

His Excellency  
Conselheiro

João Lins Vieira Carneiro de  
Serimbu.

VOL. I<sup>st</sup>

Survey of the  
Upper San Francisco  
by the  
Commissão  
Hydraulica

1879.

2  
Dimensions of Steamer  
"Presidente Dantas"

Length — 98 feet  
 Beam — 14 "  
 at Wheel Houses 26 "  
 2 cylinders 12 inches  
 Stroke 24 "  
 Diameter of Wheel 10' 9" "  
 Width " " 4' 10" "  
 Number of buckets 10.  
 Depth " " 10 inches  
 Boiler length 10' 8"  
 Dia. 5' 9"  
 Tubes size 2½"  
 Number of tubes 96

Pounds of Steam av. 35 lbs.

40 lbs. gives 26 revolutions }  
 35 " " 20 " } Machinery says  
 30 " " 17 " }

Draught of vessel loaded  
 Forward 3' 3"  
 Aft — 3.

1 Cubic metre = 35.287 Cubic feet. Say 35.28  
 C. feet.

2<sup>d</sup> Measurement of the river flow at Piranhas  
 January 23<sup>d</sup>. 1880. Sr. Lisboa

Total Area 5331 Square meters  
 Volume per second 2196 cubic meters <sup>H.</sup>  
 Mean Velocity 0.41 per sec. = 0.92 M. per  
 Greatest Depth 43 metres.

The above is based on 0.9 of the Superficial Vel.<sup>s</sup>  
 Taking it at 0.8 it would give as follows:

Volume per sec.<sup>d</sup> 1952 cubic meters  
 Mean Velocity 0.36 per sec. = 0.81 M. <sup>per H.</sup>

NOTE,

The river is about 9 metres higher than when  
 the 1<sup>st</sup> measurement was made Aug. 1879.

I call the flow Jan. 23<sup>d</sup>. 1880. 2000 c.m. per  
 or 120,000 cubic meters per minute  
 = 4,233,600 cubic feet per minute. <sup>Sec.<sup>d</sup></sup>

The steamer "Jequitanga" arrived this morning, and brought me a telegram from Sr. Plinio, saying in substance that if I had to wait for the launch Paulo Affonso, it would be more convenient to wait at Penedo than at Piranhas - and in regard to the exchange of launches although it might be of advantage on account of the draught it might be some disadvantage on account of the power of the engine.

So which I answered by telegram, to be sent on the steamer Jequitanga to Penedo and from Penedo to Rio de Janeiro, as follows

Ser. Com. <sup>do</sup> Plinio de Oliveira -  
Rio de Janeiro

Your telegram dated Penedo 18<sup>th</sup> rec'd here today. Tomorrow the Commission starts with pack-train for Jatobá. Engenheiro Krugger will construct carriage for the launch Paulo Affonso, but we will begin the survey with canoes. Much time may elapse before the launch can reach Jatobá.

I have some notes of the bar another mile below Penedo, and will get them on my return.

Letter went yesterday by the Sembrer.  
W. Milnor Roberts.

I devoted the day to reboxing, re-arranging, and repacking a large portion of our goods, so that they would be in shape and weight, suitable for pack animals. Mr. Weiser & Mr. Castro & Henrique and the

6) Thursday Aug 21 - Continued

Young Secretary doing the work, with the aid of the Carpenter and our Cook. I also made out a list of additional provisions to be had from Sr. Venturi.

10 sacks	Farinha	4	Reps of onions
6 "	Beans Fejão		Sr. Venturi's estimate of the consumption for man, was - Day,
2 "	Salt sal		1 Situ of farinha
4 "	Rice arroz		$\frac{1}{2}$ " of Fejão
100 Kilos	Sugar assucar		1 lb. of Carne sacca
80 Kilos	Coffee Cafi		

Mr Venturi said we would need 6 men to each double canoe - if we had 4 double canoes 24 men - I will try to get along with 3 double canoes - and 16 men in place of 24.

My arrangement is, to go to Rodonda with the pack-train, instead of stopping it at Jatobá. Mr Venturi indicated to Mr Weisen, upon the inquiry being made, that the charge to Jatobá would be 6 milreis per animal, and to Rodonda about 7 milreis per animal.

To day Chief Eng. Kruger has dispatched a man to Jatobá - Rodonda and Coroba, to engage Canoes who he says will reach Coroba in 5 days and return and report to us.

After writing the telegram, I wrote a letter to Com<sup>do</sup>r Plinio, sending copy of telegram and referring to Mr Kruger this assistant Mr Venturi - and also to Mr Derby, in Massé.

Thursday - Aug 21 - Continued. Piranhas

and hoping we would be on the upper river - via the falls of Paulo Affonso within a week.

I also made an arrangement with Mr Kruger's Primeira Engenheiro, Mr to keep a record of the barometer and thermometer during our absence up the river. (Our anxiety to be compensated at Stealing, and on our return.) Observations to be made at 8 A.M., 12 Noon, 4 P.M. - and 8 P.M. of the height of the barometer (its elevation above sea level to be noted) and of the height of the attached thermometer and also of the unattached thermometer.

Remarks concerning the prevailing winds, clouds, and the character of the weather could be recorded at the same time, the value of the observations would be materially greater.

~~The temperature of the wet-bulb of the thermometer, compared with that shown by the dry bulb, would serve to indicate the hygrometrical condition of the atmosphere at the place of observation.~~  
This last paragraph was omitted.

We then returned to Mr Kruger's home - Mr Seiboa in company - and had another excellent dinner.

After dinner I wrote up my diary - and made the memorandums of the day in this book.

8 Friday - Aug. 22. Piranhas

We breakfast at 8. a.m. hoping to start some time to day for Jatoba.

Rode in to office - some of the pack animals were here, and Mr Weiser attended particularly to getting them packed, seeing the leading man had bought guns - I ordered 5 pistols and one gun for the other six - the guns that the men bought were only 9\$, and the pistols at 7\$ - the other guns for sale were 25\$.

Mr. Kruger paid on account 85\$ 000  
Mr Weiser took a note of the rate of wages of the men - the 12 who are to act as a kind of body guard, and attend us

While these things were being attended to, I finished a long letter to addy - another long one to John Boquet - one to Sister Mary, and one to Sister Margartha McClellan.

Mr. Weiser succeeded in loading and starting 22 pack animals. Says it will require 33 more animals to complete all.

we engaged sails for 2 large <sup>arrayas</sup> boats - 2 <sup>canoes</sup> and one small boat - 2 canoes.

Concluded that unreasonably, cannot get away till about midday tomorrow - if there is

At about 5 P.M. Mr. Kruger, Mr Weiser and I rode out to the House and took dinner.

After dinner I brought up my Diary and finished out the letters to take with me tomorrow.

Friday Aug 22. Cont. Piranhas (9)

This evening wrote to Chas. A. Colton Manager of the Dollar Savings Bank No. 124 4<sup>th</sup> Ave. Pittsburgh, Pa. enclosing him my check on the 3<sup>rd</sup> National Bank of the City of New York No 408 for \$100, requesting him to credit Mrs. Adeline B. Roberts in trust for Milner O. Roberts for the \$100 and asking him to write to Mr. Milner Roberts Care of O. C. James 47 Rua 1<sup>o</sup> Marco São de Janeiro, Brazil.

to Mr. Colton then wrote, on another page and a half, an account of what I have been doing <sup>in my journey</sup> and gave him some idea of the San Francisco news.

And in a P.S. I ask him to mention the rest of this letter to Mr. Tho. P. R. or Mr. Christie or any of the family, saying I hoped to write to them within a day from the Upper San Francisco.

Brought up my daily Diary -

Tuesday Aug 19<sup>th</sup>

See regular Diary -

Obtained at Engineers' Office in Piranhas, as follows:

July 1879	Metro
Level low water Jatoba	287.52
Nov. 12. 1878 " Piranhas	31.18
Difference 826.11 ft.	250.34

10) Saturday - Aug. 23 - at Piranhas -  
at the house of Mr. Kruger.

I came at 6 A.M. Re arranged baggage -  
Took a cup of Choclate - Combed my letters  
of yesterday - and added a letter, to this date.  
Breakfast in Co. with Mr Kruger and Mr. Weiser

While Mr Weiser was getting some packs  
arranged for the pack- animals, and our  
bills at Venturi's were being made out,  
and the bill of articles obtained for Chief  
Engineer Kruger were being made out, I  
wrote 4 close pages description of the São  
Francisco River, addressed to Col. J. P. Barr  
Editor Pittsburg Post - dated Piranhas -  
August 23 (Province of Alagoas, Brazil) and  
signed R. I had not time to write a  
letter or note to accompany it, for just as I had  
finished it I had to attend to and sign  
the bills and papers. Engineer Kruger +  
Primeiro Engº Amarante had a discussion  
as to the form to be used. We got a copy  
of the form used by Engº. Kruger.

I wrote simply  
"Voto-e-pague-se"  
M.M.R.

Mr Kruger handed me Bill (No 352) of  
the debt of the "Comunissao Hydraulica"  
to the Estrada de Ferro Paula Affonso -  
amounting to ----- 85\$ 220.

The bills of Venturi #  
" " " São Maria #  
" " " The two #  
This sum, amounting to 2943\$ is to be paid by  
Chief Engineer Kruger  
I got to " " for  
viz- the above bills paid by C. 7000\$ 000  
and and 2943\$ 313  
Oliod'agua 4057\$ 687  
7000\$

Saturday - Aug 23. on the Railway lin 11

We start from the Home of Mr.  
Kruger at 4 P.M. and rode  
along the line, at nearly all  
points where work has been done  
on the 1<sup>st</sup> "Secção" - Night we  
took in when within a few miles of  
our stopping place Oliod'Agua  
so we arranged to go back the  
morning, in order to examine  
the big cut - 12 1/2 metres deep -  
15000 cubic metres - 400 metres  
long - chiefly sand stone rock.

Caroã a long  
grass - my strong  
used for cords.  
The finest threads  
got are stronger  
than cotton thread  
and there is abun-  
dantly got in this  
vicinity - say 31  
Kilometres from  
Piranhas - at  
Oliod'Agua  
when we slept  
the first night out

(27 Kilometres).  
We arrived at Oliod'Agua, at 7 1/4 P.M.  
and at 8 o'clock, we had an excellent  
dinner at the head quarters of Mr. Plotino  
Division Engº. All of our Comonissao baggage  
arrived and a portion of our baggage.

Mr Kruger, Weiser, Barcellos (Chief of  
Secção) Henrique, and I - and two Com-  
aradas, started from the Home; the others  
of the Comonissao started from Piranhas at  
3 P.M. - and only came 20 minutes ahead  
of us to Oliod'Agua - Station here -

A number of buildings or rather houses  
in sight - Cattle dealers homes. Then an  
quite a number of good looking Cows in this  
neighborhood - Potomac water here in a  
pool - which animals drink - Salty and  
men don't drink. There is other, better  
water about a mile from Oliod'Agua, which  
has a sweetish taste. With ice and lemon and a  
little sugar it would make a good lemonade.

We had good water - not the very best - like  
that at Piranhas - but good, which Mr. Plotino  
said had been brought from the river - 21 Kilometres  
(about 13 miles) At 9 P.M., I retired - having  
a good bed in a room, with Mr. Weiser who  
had another bed in a better.

12/ Sunday - Aug-24<sup>th</sup> - Olio d' Agua

Bachelor Plotino Soares,

At 6 $\frac{1}{2}$  a.m. Mr. Knauff, Barcellos, Plotino, Vieira, Henrique, and I, mounted our horses and rode back, over another road (double the length of the one we rode last night) to the Railway line some distance back; the sun we had passed along in the dusk.

We rode along seeing some culverts with much cheaper + more appropriate Masonry - Sandstone; but the height of the openings of the second culverts is much greater than necessary.

Time used for motor is about 12 miles. Cost 2,120. per saeco (alcantara). Mr. Derby was to have seen the limestone formation, where this line is made; and doubtless he has done so.

We soon came on the 2 per cent. grade over a piece of line, principally finished, and well located, and the cuts & fills are good; the sand stone rock prevails along here; but I saw one excellent earth borrow pit.

The summit cut (referred to page 11) is about  $\frac{2}{3}$  done - in amt. of labor; and three fourths in the quantity of material, a considerable amount of earth being in the ascending or rather level from Piranhas - here 2 per cent. grade stops before reaching the cut, <sup>at a point 1000 ft. level for a short distance</sup> then a 2 per cent. descending grade begins, and runs through the whole cut. End about 2 kilometers beyond the deep cuts to the Station - Olio d' Agua.

Mr. Barcellos said that 2 Factors nacionais (whom I saw) and 40 men had done all this work in 7 months, beginning in January. I am surprised at the quantity of work they have done - having my hand - cart; until very recently some animals have come.

Sunday - Aug-24<sup>th</sup> - Continued - Talhada<sup>13</sup>

Ht. 315<sup>m</sup> - 247<sup>m</sup> Olio d' Agua 319<sup>m</sup> Highest Summit  
[K. 25.] [K. 27.] K. 33-

Continuum 2 per cent. grade from Ht. of 315<sup>m</sup> to Sta. Olio d' Agua - <sup>descending</sup> Then ascending grades 6 kilometers from Olio d' Agua to the Highest summit (4 meters higher than the one we examined before breakfast).

Returned to Olio d' Agua to breakfast at 8 $\frac{1}{2}$  Breakfast 9 $\frac{1}{4}$ .

I am not quite sure that the location of grade and position of line in passing the summit we have examined is exactly the best - but from the statement of Mr. K. and Mr. Barcellos, it is but through the lowest depression of the ridge. I cannot safely criticize it adversely - though it is a big cut. It has been remarkably well worked to have so much done in 7 months.

We had intended breakfasting ahead at 10 a.m. but breakfast being nearly ready here we stopped & breakfasted at Olio d' Agua.

Left Olio d' Agua, again, after breakfast. Mr. Plotinho - Divisao Engineer accompanying us Mr. Barcellos, Chefe de Seccao, who was with us from Piranhas, parted with us here, and returned to Piranhas.

At 11 $\frac{1}{2}$  a.m. in the midst of a very rocky region, Sandstone - in some places, many piled one upon another, with large rocky ridgy bluffs - At 11.50 we cross the Rio Once - no water, only a flat bottom of Coara sand. Sometimes water flows here, but not in great quantity, and not long at a time - We stop 5 minutes, and take a drink of water - at 12.10 we reach Talhada - where Mr. <sup>has his</sup> Engineer Station

14 Sunday Aug. 24. Continued - Talhada.

Sr. Plotinho's division ends at the Rio Onca. and Sr. Man. Vol. de Terra begins.

We stop here and find Mr Derby. Breakfast had been ordered here for us and they waited till quite late. We took some curds or Cheese & Milk, good, they have also fresh butter here. We finished with a cup of excellent Coffea cum Lacta made in a patent French Coffe Pot. [Mat. vol de Terra]

A good deal of the way from Oles d'agua to Talhada the ground is favorable for the railway, and for the launch; but there are some depressions, and rocky places; the undulations where they occur are rather heavier than they appeared on the first few miles from Pirantã; after attaining the general height of the plains

We lunch in the house where the Emperor, and the Duke of Saxe Coburg passed the night on their way to the Falls of Paulo Affonso in the year - Talhada  
Milk, & butter

Mr Derby says he was on to see the limestone formation, 3 or 4 leagues from here. He showed me a large specimen. It is a marble, quite white, streaked with serpentine and laminae of sulphate of lime or of gypsum, as it appears to me. The lime that I saw along the line - said to be made from this stone is very good.

Our horns were unsaddled and put into the stable, seeing all hands a Siesta. The sun is quite warm; but since stopping here a breeze has sprung up which makes it very pleasant in the shade.

There is a fine view from the porch of this house first of a large dish shaped valley, then rising hills then a high rocky knob (sandstone) which is partly an in come along, then a low mountain range

Sunday - Aug 24<sup>th</sup> Continued - Talhada 15

a few miles beyond to the S.E. from here, at a distance to P. da Pedra the mountain hills and valleys appear as if covered with forest; but when near, it is seen that they are still only the Sertão - scattered, low trees, with Cactes in great abundance, and a thin sandy, or rocky soil, almost everywhere. Only a few small exceptional spots, which have been second and cultivated - a little, very little, corn, and some vegetables. Melons grow very well; but the people, the few who belong to this region, independently of the railway works, do not attempt to raise much of any thing, except Cattle.

In the midst of the scrubby trees and cactuses there are grass and bushes which afford grazing, when the region is not devastated with drought. but the superficial appearance of the earth of the rocks, of the dry beds of sand in the bottoms of all the rivers, (showing that only at intervals, and for comparatively short periods do they have flowing water in them) [There are trees growing in the beds of these streams which would be killed were the streams to be flowing with water continuously, even for a few months.]

The great want and need of this country is water, and a deeper soil. (Probably if this were a rainy region the disintegration of the rocks might have been greater. If post had been an accompaniment the disintegration would have been much greater.

The rock, as a rule, shows every where near the surface, not only in the railway cuts, but all along the roads we travel; and all the ridges and mountains are rocky. Along here they are sand stone.

The "limestone" about 12 miles from here, is a white marble, which makes good lime.

At 3.20 - We leave Talhada - Mr Derby in co. and ride 12 Kilometers - by the road, to Pedra much of the way in sight of the railway clearing. The sun was very warm this afternoon.



16 Sunday Aug 24 - Contd. Faz. da Pedra

Arrive at Pedra at 5.25 - and find the main body of the Comissão awaiting our arrival. Here we are to spend the night

Dr. Crockett de Sa Chefe de Secção. Livio dos Reis - 1<sup>st</sup> C. Eng<sup>r</sup>

Beautiful view of distant - not very distant Mountain range - with cultivation on the Mountain and at the foot of the Mountain - P.M. two hours seen through our glasses, 6.10

6.10 Darker has come - Stops me, 6.10

Crockett de Sa - Chefe de Secção

Livio dos Reis (Col.) 1<sup>st</sup> C. Eng<sup>r</sup>

These engineers are in charge of the Second Secção - which begins at the "Rio Once" - where Dr.

Our entire party had a very nice dinner, with 3 Cadis to grace the table; Mrs Sa - Mrs <sup>mother in law</sup> and Mrs - There were 18 at table.

A lovely moon light night with Venus just retiring, and Jupiter just rising, and a delightful temperature, clear the day.

Our programme is, to go tomorrow, after an early breakfast, to the Great Falls of Paulo Affonso - there to remain over night - and some time next day, come back to the Rail Road line.

I am provided with a comfortable bed, so bidding all "good night" & saying, for wife, babies & all, I say Good Night.

Monday - Aug 25, Fazenda da Pedra 17  
6.1/2 a.m. - walk 1/4 mile, or more, to the Pedra (Piles)

Sandstone Pedra about 35 ft high on a flat sand plain covered with smaller sand stone boulders. Cactus small large bushes, and jag tree Redank trees - on a rather light greyish soil view within 100 ft. from S. toward N.



After making this sketch I noticed that much finer views can be had farther off from the Pedra.

Returning to the Home at 6.50, I am greatly amused at the efforts of a pair of parrots to imitate all sorts of sounds; calling "Anna, Anna!" saying popagania - then saying some words of perfect Portuguese - then laughing - then it said Milena, then per, sur, then crying, like the baby - then the baby actually did cry - and the popagania laughed. It imitated crying very successfully - then more Portuguese words which I cannot get distinctly enough to read - then imitating birds - then, when some birds began making noise - the popagania became quiet for a couple of minutes. Now there are two parrots opposite each other chattering away. These are large and handsome. It is said that there are plenty of parrots about here.

The mountain range north of us, is hidden this morning, by fog. The real cry of the baby, and the awful comical imitation by the Parrot - succeeded by a hearty laugh and more Portuguese, in a female voice, are startling. The poor child as represented by the Parrot must be greatly given to crying. It is the greatest variety I ever heard given by a parrot - and no one near it.

The fog begins to fade away before the morning air; but as we are to start about 8 o'clock it may not be sufficiently clear to get a good view with our glasses, of the cultivation on the Mountain side, and at the foot. 7 1/2 AM. It is quite cool this morning, and cloudy -

This is a very pretty situation; but a large proportion of all the ground we see appears to be fit for nothing but grazing, owing to the scarcity of water and the thin (coarse sand) soil, the rocks here, as elsewhere in the region as far as we have traversed it being very near the surface.

The drinking water at the Engenho's House here is very good. It is rain water. But rain does not always occur here. This season is said to be exceptional, and the verdure which now prevails disappears.

It is said that they have <sup>good</sup> water on the mountain range, a few miles north; and I have no doubt this is correct.

### Breakfast

8<sup>30</sup> a.m. I see now that there is village of scattered houses over at the foot of the above mentioned mountain.

9<sup>15</sup> a.m. we start for Falls of Paulo Affonso.

in one Kil'omede we cross the railway clearing and get on road to the falls. It is undulating - sand-stony near and at the surface - the fruit scrubby here, cactus, of several kinds, wild fig, said to be poisonous and an emetic.

an occasional house - suppose cattle raise

10.45 Park is different - not ordinary sandstone & not granite. We pause 5 minutes.

10.50 Start.

11.00 Pass a cluster of houses - with a pumpkin field and water melon ground - otherwise, no agriculture. Road in places stony - in other places filled with debris of quartz rocks - white quartz. There may <sup>now</sup> be a gold mine beneath.

12.00 We arrive at Caza - Marcellino's - a large Col<sup>d</sup> man with quite a family. He says it is a quarter of a league - about a mile, to the river - and about 3 leagues to the Falls - Here we get a supply of nice fresh milk and eggs - and conclude to rest an hour or <sup>partly</sup> two. It is not a very hot day; but it is warm - there are clouds flying and a pleasant breeze. It is quite pleasant in the shade.

The ground around here looks a little more fertile. We have Passoa Lagoas, with still a little water in them, in spots.

We remained at the mud edifice (Caza) of Sr. Marcellino 2 hours - resting and much parking the animals. During our stop the baggage from the animals and passed on.

Two <sup>women</sup> were spinning cotton in the real primitive style, without the intervention of a wheel. All done with their fingers - the cotton was very white, fine & beautiful.

The cotton was raised at or near the foot of the mountain in front of the Fazenda da Pedra, supposed to be from some 15 or 20 miles from this Caza.

They raise nothing here but cattle, & goats. They have very good milk and make some butter and some cheese; but there is here no agriculture whatever. This place is within one mile of the S. Francisco River.

2 P.M. - we start and ride 2 hours at about 5 miles an hour to the Falls of Paulo Affonso. Day 10, or 9 miles.

There are two mud edifices, and a shed for animals - on poles covered with leaves for shelter - [On the river we pass along in rich and partly parallel with the rocky, Mt. range, Serra d'Algebra nearly the same thin sandy soil, rich near the surface cactus, and scattering trees. In a few miles there was a show of grass - of two kinds, one of which called is said to be the best natural grass in Brazil - the other grass called is longer and has a sweetener to our timothy; though it is not timothy.] An Indian, who acts as guide to those who need a guide, went ahead of us to the view (as they think it) of the Falls, about a mile from our camping place, below our camp. Camp is a short 1/2 mile from the river above the Falls. I saw the view, but was well satisfied that it was only a "sid-show", and not the Great Falls. On our way to this we passed the monument put up in 1869 by Commodore the Imperial visit - Oct. 20 - 1859. I was in Brazil in the Province of Rio de Janeiro, when the Emperor made this visit.

20 August 25/26 1879

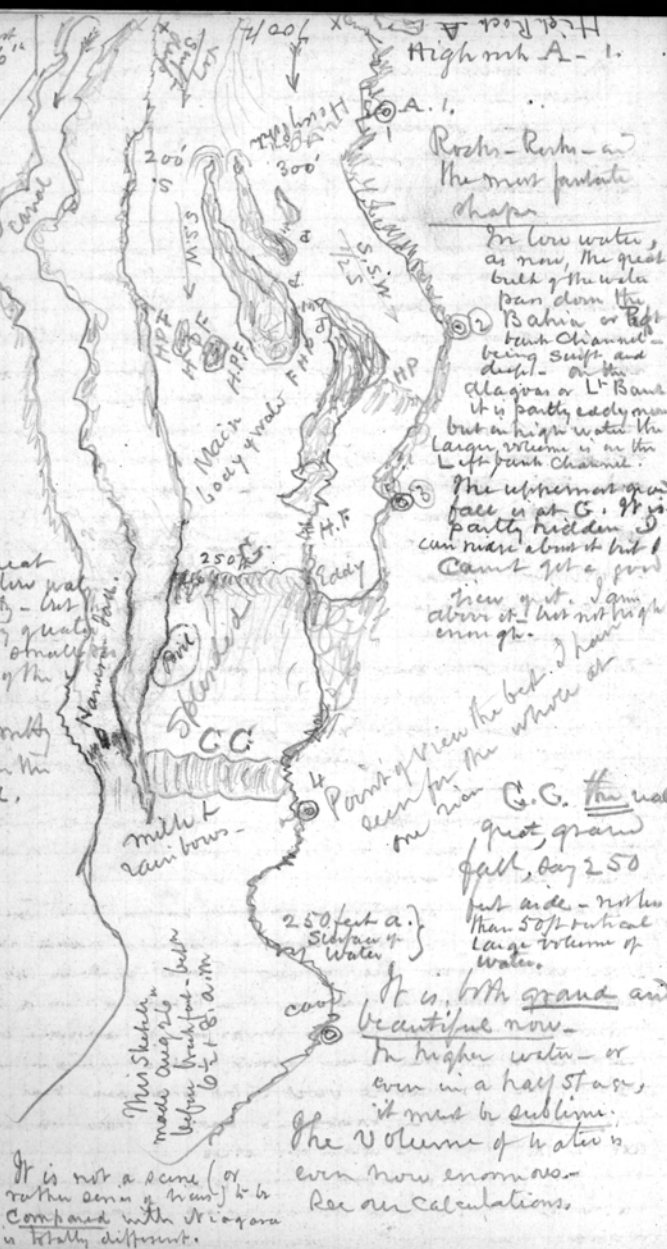
Very rough - not at all accurate but will give you an idea of the general nature of this part of the Cataracts.

The great fall in low water for months - but quantity of water is but a small portion of the

The pink fall from the Canal.

They of upper classification E.S.W. 80° N 50°

It is not a scene of rather even a thousand compared with Niagara which is totally different.



Rocks - Rocks - a) The most fantastic shape

In low water, as now, the great bulk of the water pass down the Bahia or Right Bank Channel - being swift and deep - on the Alagoas or Left Bank it is partly easy ground but in high water the larger volume is in the Left Bank Channel.

The uppermost great fall is at G. It is partly hidden & can't see it but I can't get a good view of it. I am above it but not high enough.

A point of view the best seen on the whole at or near C.G. The real great grand fall, say 250 feet wide - not less than 50 ft vertical large volume of water.

It is, both grand and beautiful now.

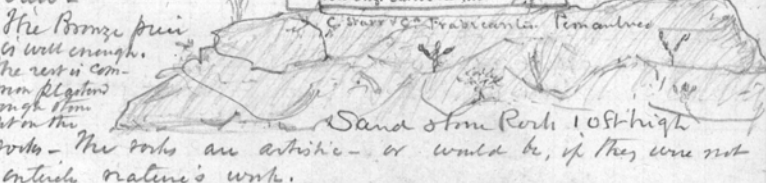
In higher water - or even in a half stage it must be sublime.

The volume of water is even now enormous - see our calculations.

August 25 - Monday - Paulo Alfonso 21

On arriving at 4, P. M. - at our camping place we went on no horse back - to the nearest point an Indian guide - wholly unnecessary to us, in front some of our party having preceded us - and when on our returning - they thinking they had seen the Falls - from what I had read and heard about them Falls I was satisfied that they could have had only a very partial view - at some one point; and so it proved. We saw The Falls, on the Bahia side, which comes from a Canal branch of the main stream - which is very pretty - divided by an island in the middle - a miniature of Niagara - and we saw the mouth of the cave - which is near the wheel quarter below the falls on the Alagoas side. It is some 30 ft wide & 40 or 50 ft high jutting for appearance for 200 ft above it - and it is said to be 140 Steps long.

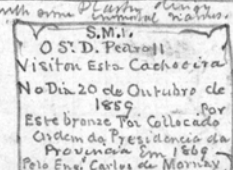
The Monument on the left hand the over toward the plumb, ugly, and artistic effort as any saw -



The Bronze piece is well enough. The rest is common plating though seen at in the rocks - The rocks are artistic - or would be, if they were not entirely nature's work.

One good thing about this monument is that the President of the Province in 1869 - did not have his name put upon the plate. Only the Emperor, Eng<sup>o</sup> Morrey and C. Starr & Co - appear by name - The Bronze is now a dull black. Originally I suppose it was pretty - It answers its purpose; but while they were about such a thing - Commemorating an Imperial visit to the grandest natural object in Brazil, a more imposing and a more characteristic design should have been selected.

The walking, or Stone & sand slipping to get to points to view the Falls is about as rough & as good as could well be found. The water seems to have blackened the rocks. Black patches,



is a black slat side going down fall, as Com - free from any thing I ever

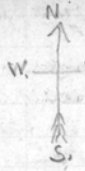
just below the present sketch is one of the my grandest of Nature's Hydraulic operations.

On a much smaller scale, but still well worth seeing are the Falls of the Spokane River in Washington Territory, U.S.A - which I explored a year ago - the rapids, and the irregular falls constitute a miniature and softened picture of the perfectly rugged scene now before me.

The resistive power of heavy volumes of descending water are here my forcibly and graphically exhibited. One does not seem tired of looking at its ceaseless movements.

I leveled (with my eye) from the surface of the present water to a point where there are unmistakable evidences that the water sometimes flows in floods - and made it 30 ft. I think that it rises or has risen to a height of 35 feet at this point (or possibly more). 35 ft. is the height of the rocky the near which, at the same elevation, I made these notes.

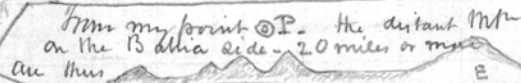
It showed half a dozen times during my stay here 1 1/2 hours 10 1/2 to 12 noon - and I used the body of the tree 1 1/2 to 1 3/4 ft. dia. for shelter. The cross section of a 30 ft flood, any where along here, for half a mile, would be quite different even at intervals of 100 feet. I can therefore only attempt a very rough approximation of an unusually cross section.



Rough sketch of approach to the Falls from above - The extreme upper point in view A. is about 1 mile above the beginning of the Great Falls.

Every part of this is swift and deep, and the water strikes the rocky points with great force - causing violent reactions.

The widths on this mile of river are very various - the narrowest points being about B. B. - being not over 300 ft. - The other narrow points 400 to 500 ft. - and the widest 800 to 1000 ft.



From my point P. the distant Mt. on the B. B. side is 2.0 miles or more. The Great fall begins just below here - see page 21.

Every where frequent irregular splashes mixed with beach-like rocks - being from a velocity low on the high parts of banks of the river - great splashes sound on high ground.

There is a vast volume of water passing here now, with the river in its low stage, though not at its extreme lowest. (It is called quite low)

When I look over this expanse of rugged rocks, which now confine the water within these comparatively (natural) narrow channels, and observe the evidences of the vastly greater volume of water, the increased depth and augmented velocity of the flow [perhaps 6 to 8 times the present quantity of water - see future calculation] I feel quite confident, that when the San Francisco River is in high flood, that here, along this mile of river, and including the Great Falls

About 1 P.M. our party began to assemble preparatory to starting - which had been fixed at 2 P.M. Our Indian it seems is the head of the house here, and the father of 10 children - He brought several very fair watermelons - one of them a white one - which we discuss - I took also about 1/2 pint of Milk - This man lost 85 Cuen by a drought - he has 30 left. We had showers all the morning - It began in the early morn as a fine rain - It made the grass & bushes very wet - which soaked boots & pantalons.

1.45 We start and ride up the river - Naturally on a river bank, but on the irregular gently sloping bank with stony & scattered trees - and not much chance for cultivating any thing. About 2 miles up from our Camp, it is a trifle better - there is rather more soil - and of a more clayey nature.

The river, off to our left, winds, and spreads into various channels, with rocky shores, and occasional rapids - one quite decided.

2.45 One league up - we leave the river, soon after having crossed a very river - The country deep the S. Francisco - in Bahia at this part of the valley shows cultivation - and there is a little on the Alagoas side - a few miles from the river S.F. we strike the Moxoto river - which could be quite a considerable stream if filled with water - as it is for heavy rains. Now it is entirely dry - some rice cultivation by the colored population chiefly with melons - In one place we saw Tobacco - The plants looked thirsty - but there had been some failure of a large majority, and re-planting had been done.

4 P.M. We crossed the dry bed of the Moxoto - 500 to 600 ft. wide - sandy & clayey and we are now in Pernambuco - we now ride along

on the right bank or slopes of the Moxoto, in the Provincia of Pernambuco - we pass a out of a villega of huts about 4 1/2 P.M. - Called

5 1/2 P.M. - my time - 3 1/2 hours from starting, we arrived at Moxoto - Sr. Lobato, Chief of Seccao's head quarter - When we are kindly received in a very good house arranged for the Engineer -

There are several other houses - not so good - and a small white Church.

There is to be a bridge here 1524 meters about 500 ft. - 5 spans of 25' & 2 of 20' = 165' 5 of 82 ft. - and 2 of 65 ft each = 540 ft.

The bed of the River here is sandy - that which I took to be boulders, is, I suppose, the irregular sandy bottom of the river.

In floods this valley has the appearance of passing a large volume of water. Not enough trouble to put in foundations of piers.

Unless the sapentudium is pretty cheap per foot, it might have been better to have had shorter spans; but I would not criticize the length of spans adopted here - not harshly.

In this vicinity they raise Mandioca, Beans, some corn - Cotton - Tobacco, and Sweet potatoes, and Melons; but not on a large scale. Each man raises but little more than he and his family need. Cattle, swine and goats - seem to be the principal products.

It is quite evident that this is what we call in the United States "a thunder-gust" stream. It rains while it rains, and for a little while after - and this seems to be the nature of every tributary of the S. Francisco, as far as we have come.

# Very little Railway Pabulum this far Moxoto - or is Kijimotus a burr Piranhas.

26) Wed. Aug 27<sup>th</sup> Moxoto - cloudy -

We have arranged to go to day a short journey - to another station in the 3<sup>rd</sup> Division. Sr. Lobato's

Our provisions bought in Piranhas and the boards for the Canoes have not yet arrived - they were at Olinda d'Agua Night before last. It is foggy in the M<sup>orn</sup>.

7<sup>1</sup>/<sub>4</sub> a.m. - we will breakfast, and start later.

The railroad line crosses the Moxoto River just below here; with a bridge, as already described, it then makes a tolerably direct line for the river, striking it about half way between Moxoto and Jatoba - Jatoba is said to be about 32 Kilometers from here.

8<sup>1</sup>/<sub>4</sub> a.m. All of a sudden we are called to mount. It seems that there has been a misunderstanding among the people here, as Mr. Krieger supposed, intended preparing breakfast, but they did not so understand. So we must ride 15 Kilometers (about 10 miles,) for breakfast - as our provisions have gone ahead with the packtrain. Well, I had an elegant cup of Chocolate and some little cakes early this morning. I'm all right.

We ride along in sight of the line much of the way crossing it several times, on sandy ground, smooth, very gently undulations - curves of large radius. There would be scarcely any work were it not that the rock is not far beneath the surface.

We stop and examine a water tank cut in the rock - it is about 20 ft diameter - and about 20 ft deep when filled - 1/2 full now - to catch the flow from rain. 130 c. miles of rock were excavated - hard Sandstone.

We saw two other tanks on the route this morning. The stone that was blasted out was built with a wall enclosing the tank.

These tanks were necessary preliminary to working men and horses on construction.

Wed. Aug 27<sup>th</sup> Moxoto to Quixaba (27)

As far as I can judge, and the opportunity of judging is very good, the line appears to be properly located.

About 9 or 10 Kilometers out we strike a small river the Dos Bananeiras dry, of course, and we and the line follow it for a couple of Kilometers - the line then crosses it and keeps to the right, while the Bananeiras runs off to the left and joins the San Francisco -

10.35 - we arrive at Station Quixaba - of the Eng<sup>o</sup> Mr. Albuquerque - ~~Chief of Station~~ - in charge - of Division -

Quixaba - pronounced Kishá bahó is in the gently sloping side hill at the foot of the Serra do Capim. It is a continuation of the Serra do Caratú (Serra) There is a plateau or knoll of the Serra 4 or 5 miles from here back, called Serra do Brejo. But there are on the main range of the Serra Caratú.

Memorandum!!  
The Cachoeira de Tocado - in the S.F. River is about 3 1/2 Kilometers below this Station.

The Cachoeira da Itaparica is about 7 Kilometers above here at (just above) a sharp bend in the river. The Serra Brejo - (Pico de Fora) on the left or Pernambuco side is just opposite the Falls. about 1 Lequa below Jatoba.

The river just below the Itaparica Falls is very narrow, confined between Rocky Shores, but just above the falls the river is very wide 3 or 4 times as wide as the narrows. Canoes cannot pass the Itaparica Falls in the present stage of the water. There is an island (there must be two islands) as a man who claims to know says there are three channels. Mr. Krauss's sketch or map represents an island.

Cachoeira do Bode - [Below which there is good canoe navigation to the smooth water above the Falls of Paulo Affonso, is about 3 1/2 Leguas below the Falls of Itaparica, and the Bode Fall can be passed with canoes in higher water.

28 Wed. Aug 27 - Quixamba. 3 Bottles Berlin Bier.

Gave in a nice breakfast - a bar room. a nest of nice White Henk - Police - the last

Cacoeira do Rocado. About 2/3 Leaguas below Cacoeira da Itaparica. There is a strong current here; but Canoes can pass - So says my informant, an emphatic partly Colad elderly individual.

Mouth of the Rio Moxoto. appears to be about (very nearly) 3 Leaguas below Cacoeira do Bode. About a league above the mouth of the Moxoto across the Cacoeira Tigre - informant says it is small - that Canoes can pass it. Not a serious obstruction -

Note - That if the Rio S.F. can be made fairly navigable down as far as the Rio Moxoto - the R. Way could turn down the Moxoto - and stop at or near its mouth. In that case, possibly, the R. Way line might have to leave the present route 12 or 13 Kilometers before reaching the Moxoto River where it is now located.

Much depends upon the nature of the Falls of Itaparica - and something upon the nature of the Rocado and Bode and Tigre; all of which are below Jatoba and above the mouth of the Moxoto River.

Since writing the foregoing I have read Britton's account of the Falls of Itaparica - from which it appears that they are much too great to think of making a navigation through them without building locks. If so, there can be no doubt that the location of the terminus of the Railway on the high S. Francisco should be above that Falls. But whether it would be better above or below Jatoba I cannot yet judge. With the new location of the line it is decided to be at or above Jatoba. See future observations (Aug 27 - Quixamba.)

Thursday - Aug 28. Quixamba to ... all of our own animals were fed with corn that we gained during the latter part of the night though beautifully clear in the evening. It is cloudy, and cool, this morning, and does not look like rain - though there is no security, as the changes are very rapid in the region we have been in.

Our pack train starts at 6.52 - and ride over very favorable (sandy without wider rocks) ground for the railway - nearly level or with very gentle declivities for an hour - some 4 or 5 miles. We pass around on the West or north side of the Brejinho Mount or Muro - on the new line, which they are now clearing through. The old line ran down to the river, ~~the~~ on the other side of this Mount. Brejinho (on the river side). The new line, as Mr. Kreigher informed me, was selected in order to make a better approach to the best anchorage or deep water. In order to get this line the route starts out up-stream at the river, at Jatoba - and then curves around, passing as above stated behind the Mount Brejinho; but involving some additional elevation, as there is an up-grade for some distance, after having descended considerably toward the river - then a 2. per cent. grade is involved in getting out from the river valley. Another reason assigned, by the Chief of Seccao Sr. D. Lobato, is that on the lower or river line it encountered heavy cutting, which is avoided on the upper line.

I can judge better about this change when I see the terminus at Jatoba. 8.27 - we pass a number of houses - Fazenda de Brejinho - A handsome row of Palmetto trees, trees with the exception of one or two isolated trees, we have not seen for some days - very sandy soil on the last 2 miles in to the Engineers Station Jatoba. 8.57 - we arrive at Estacao Jatoba. Sr. Sabato and Albuquerque accompany in the morning - 9 A.M.

Trough Hurry September - not ready to start when in left Quixamba

9 AM. At the Engine Station - The Last.

We walk down about  $\frac{1}{3}$  of a mile to the river; and here it is a river, broad and smooth - not less than half a mile wide - with high sandy alluvial banks with little farms on both sides of the river; but looks to be more extensive on the Bahia or Right bank. The general valley is wide and open except a few low scattering trees and bushes.

At this particular point there is a bluff rock some 20 ft high, with 6 to 7 meters depth in front and for some distance out. It is a good place in low water or a medium stage perhaps; but I should think from the deeply water-worn jutting rocks that in high water there must be a very strong current right here.

I walked down along the old line (which came up the river) for nearly a mile - and then on to the river bank <sup>to the terminus,</sup> follow the sand-bar which begins just below <sup>the terminus,</sup> when there is a ledge of rocks put out; and where the river begins to bend to the left, descending. There is no obstruction or any thing to break the smooth surface of the river; but I can see that sand bars prevail on this side, and that the main channel opposite here is probably on the Bahia side of the river, or possibly near the middle.

The only point unsettled in my mind now is, whether a terminus could have been had several miles below the place selected, without having more than 2 percent grade after leaving the river? Whether there is a place as good, in low water, and as good, or better in high water? If there is and if the channel is of sufficient depth from above to such point, it would save several miles of railway.

### Jatoba Port - That is to be.

The place selected is at a point on the river where there is deep water (6 to 7 meters in low water - with a perpendicular frontage of rock ranging from  $4\frac{1}{2}$  to  $5\frac{1}{2}$  meters above the water, and behind that a sandy clayey bank overtopping the rock at a height of about 14 to 15 meters above low water.

The river runs in floods about 10 meters above low water - so that the level of the flood line is 5 meters above the average height of the frontage of rock - and as the railway grade is to be 2 meters high - the grade will be 7 meters above the average rock frontage.

This rock frontage has a gentle concave curve - say 50 ft. <sup>or  $\frac{1}{2}$  meter</sup> <sup>at  $\frac{1}{2}$  meter height</sup> chord. It may be less or more.

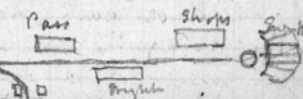
In low water a point of rock, which just a little into the river, takes the force of the current, and makes it comparatively still opposite the rock frontage. The great width of the stream and its depth, on the Pernambuco or left bank side, also slacken the current, and here there is little force in the river. The river flows toward the Bahia or Right bank.

There is a point on the Bahia side about a mile above Jatoba which throws the water over to the Concave Pernambuco side - then the rock frontage at Jatoba helps to throw the current over to the Bahia side, and Mr. Krieger says that the channel does not get back to the left bank before reaching the Falls of Itaperica. That it continues shoal or without a fit harbor all the way down from Jatoba to the Falls of Itaperica. If so, then there can be no doubt that the proper place for the terminus on the Upper San Francisco has been selected.

The approach to it behind the Morro Brejinho, instead of around in front where it was first run, is shorter and has less work, and not having more than 2 percent grade in getting out from the river, is probably the better location.

I looked at the ground for the approach from the new direction - Mr. Weiser suggested a vertical instead of an inclined front for front purposes of loading and unloading ~~from~~ between cars and boats. A simple crane will do all the work of transferring my well ~~to~~ even a considerable ~~bumper~~ - another track could be laid -

A breakwater of ~~its~~ <sup>its</sup> ~~type~~ <sup>type</sup> may be found means to make this a safe harbor in high water.





82 Thursday - Aug 28. Rodonde - Atalha.

[Showery during the day.]

We leave Jatoba at 2 P.M. - arrive opposite Rodonde - about 3:45 - and at Atalha at 4:15 P.M.

Jatoba at present is Nothing - Engr. quarters <sup>nothing more,</sup>

Rodonde - Consists of about half a dozen houses scattered - amounting to little more than nothing. We did not stop in Rodonde

Atalha - is less than Rodonde - and more than Jatoba. The casa of Jose Manoel de Souza, is the principal and only point of business, apparently. He says there are 2 small Canoes here. He says a Canoe can go down to Itapanica Falls & back in a day.

Thursday - Aug. 28<sup>th</sup> - concludes with a dinner by Camp-light under the porch of our new friend Jose Manoel de Souza, and parting with our friends, Mr. Knieger and Mr. Sabato Chefe de Seccao.

Mr. Knieger started at 9 P.M. with Mr. Sabato - taking with him my letters - one to Sr. Plinio the other to my wife. It is a fine moonlight night - and they will ride to Quixaba in 4 hours.

It rained during the night, but not hard.

\* Several of the views are grand, much finer than any of the pictures I have seen. Sampaio took several admirable sketches. All of the Commissions are well, and Sen Derby the Geologist.

Commodore Plinio 5 1/2 days!

Atalha above Jatoba on the S. Francisco River Aug 28<sup>th</sup>

(33)

We left Piranhas on Saturday August 23<sup>rd</sup> and arrived here this evening. Mr. Knieger who has accompanied us all the way, intends returning ~~at 10 o'clock to-night~~ <sup>early in the morning</sup>, and I embrace the opportunity of writing - nothing necessarily briefly.

I will first mention, that Mr. Knieger and his staff, all along the route, have attended to the members of the Commissions ~~with~~ most assiduously, our journey thus far has thus been made as pleasant as possible. We have viewed nearly the entire line of Railway, and we have seen the work that has been thus far accomplished, besides having the great pleasure of viewing the Falls of Paulo Affonso - in the afternoon of the 25<sup>th</sup> and morning of the 26<sup>th</sup>. The Falls exceeded my anticipation. I viewed them from five different points; and several of the views are grand, much finer than any of the pictures I have seen. \* See back one leaf

Last night we slept at Quixaba - and departed about noon to-day at Jatoba - the last station of the Engineers on the Paulo Affonso <sup>and Camp Sabato here</sup> Railway - <sup>1</sup> Our main pack-train is behind, but expected to reach here tomorrow -

at Jatoba there is nothing whatever except the Engineers Station house -

Rodonde has half a dozen mud huts and Atalha consists of a few huts, and one sort of house Jose Manoel de Souza, who does the little business -

The Country thus far yields scarcely anything.

Our man who went to Cabroba to get Canoes for us and our baggage, is expected back to-morrow - Meanwhile we are encamped here and will work on the river to-morrow -

I will write to Mr. K. as early as another opportunity, a day or two later. I wish to write more carefully about these things.

34) Original of Letter to the Minister Siminho, dated at Atalha, Province of Pernambuco, August 29, 1879.

## We left Piranhas on the 23<sup>d</sup> of August, accompanied by Chief Engineer Kreiger, who was both guide and friendly adviser, to whom, and his staff we are greatly indebted for many attentions which rendered our journey agreeable.

All the way we travelled either along the cleared route of the railway, or along the road generally in new lands near the line, excepting only a portion between the Fazenda das Pedras and Moxoto.

We went from the former to the Falls of Paulo Affonso and came from the Falls to Moxoto, passing for some distance up the Valley of this dry stream, in which there has been no flowing water for several years.

Having examined the maps and profiles, I have seen substantially, the entire line of railway as located.

The location.

The location of the line has been made with care and intelligent judgment. I have in my previous letter referred to the first ten kilometers. The early pioneers who established the road between Piranhas at some point on the lower river and the upper San Francisco, seem to have located a very general route. This was the basis for Mr. Krauss's preliminary studies for the line of railway. Of course many local improvements have been effected in the final location of the railway line. I am satisfied that Jatoba is the best place to locate the terminus of the line.

Construction.

The excavations and embankments as far as they are finished, have been well made. They form a good bed for a first class metric-gauge and at some future day, if deemed advisable, a wide gauge track could be laid upon it. My opinion is, however, that here the metric-gauge is the proper gauge, and that it need not be changed, to any other gauge.

The masonry of the culverts, beyond the first ten kilometers, is of a less costly character and more appropriate to the region than that near Piranhas. I would not have had any masonry on any part of this line; and I would have adopted culverts of less height in proportion to their width; but these, compared with the main features of the railway, are of minor importance.

Along the route, at a number of points, I saw water-pits, which the Chief Engineer had caused to be excavated, to store up rain water for the laborers and animals engaged in the works; which I presume was a necessary precaution, as the whole region is excessively dry. The rains and showers which have occurred - in June, July, and part of August, of this year, have had no effect in restoring water to the streams crossed by the railway line; they are all perfectly dry and have been dry (excepting momentarily after showers) for a long time - it is said that there has been no flowing water in the Moxoto for three years.

Water is the great need of all the region we have traversed from Piranhas to this point. The soil, where the rocks and stones permit any soil, is very thin, and very sandy; and for want of water, not capable of profitable cultivation. There are a few small patches, where melons and similar products are raised; but for corn, mandiocca, cotton, etc., the mountains on the one hand, and the very limited patches of new bottom that may exist along the margin of the stream between Piranhas and Jatoba - afford the only chance. Cattle, however, find pasture in the sertão; and milk and a little butter and some cheese are made; but there is no inducement for a class of regular farmers to attempt a living in the region described.

Superintendence and direction of the works.

The Assistant Engineers on the line are all intelligent, educated young men; Brazilians; and they appear to be in vigorous and active in the performance of their engineering duties. I have been quite favorably impressed with the manner in which the work generally has been conducted by them, under the instruction

The masonry of the culverts, beyond the first ten kilometers, is of a less costly character and more appropriate to the region than that near Piranhas. I would not have had any masonry on any part of this line; and I would have adopted culverts of less height in proportion to their width; but these, compared with the main features of the railway, are of minor importance.

The foremen, natives of the Country, have been well trained in working the Labours to the best advantage that the Circumstances admit of. Until quite recently, they had no animals, and all the hauling out of the deep-cuts, had to be done by men with hand-carts. They are only ~~now~~ beginning to work animals. Considering the fact that the work had to be done under such disadvantages, I was greatly surprised at the amount of work which had been done, on the Reverted Deep-cut <sup>on the line</sup> Cavalon, near Olho d'Agua. I judge that it is two thirds done, and it was only begun in January. -

The <sup>made</sup> road, for the convenience of the railway construction, <sup>^</sup> has been well located, and is well adapted to its intended purposes. On a large portion of the route it is good enough for <sup>comparatively</sup> the easy <sup>conveyance</sup> of heavy cargoes on wheels; but there are places, crossing the dry valleys, where the grade is <sup>occasionally</sup> considerably more abrupt where the progress of a heavy Carriage would be more slow and difficult. I should anticipate that on this route, where the Cattle-<sup>men</sup> <sup>and some mules</sup> <sup>are</sup> <sup>not</sup> <sup>first</sup> <sup>class</sup>, and where the <sup>part</sup> <sup>of</sup> <sup>the</sup> <sup>road</sup> <sup>is</sup> <sup>very</sup> <sup>thin</sup>, <sup>it</sup> <sup>will</sup> <sup>be</sup> <sup>a</sup> <sup>tedious</sup> <sup>and</sup> <sup>difficult</sup> <sup>task</sup> to get the steam launch <sup>sent</sup> <sup>along</sup>.

The Chief Engineer had <sup>given</sup> <sup>directions</sup> to have this road improved; and <sup>we</sup> <sup>saw</sup> <sup>men</sup> <sup>at</sup> <sup>work</sup> in places straightening and otherwise improving it. For the regular railway purposes, it is a very good <sup>common</sup> road throughout.

It was to me unexpected to see how well the ground generally is adapted to furnish good roads, with little more work than the clearing off of the small scattered trees and Cactuses - some of which are trees.

In regard to the use of a steam launch drawing a mule and a mule, water - which ought to be <sup>at</sup> <sup>least</sup> <sup>1 1/2</sup> <sup>meters</sup> <sup>deep</sup> in the bad places, the opinion is that it cannot run at the present time; but I do not depend

upon this opinion; and as soon as we can get Canoes, I will have <sup>some</sup> <sup>men</sup> <sup>to</sup> <sup>work</sup> <sup>up</sup> <sup>the</sup> <sup>river</sup>, and I will <sup>communicate</sup> the result to Chief Engineer Kreiger.

At Jatoba, there is at present nothing whatever, excepting the house of the Engineers Station; and at Rodonde, and here it is only a little better. But for the Cattle, which range back from the immediate river valley, <sup>the</sup> <sup>people</sup> <sup>who</sup> <sup>are</sup> <sup>here</sup> <sup>could</sup> <sup>not</sup> <sup>stay</sup>, as the river slopes - are almost perfectly barren. Here and there patches of river bottom are rudely cultivated; but in high water these are inundated. Yet people do manage to live here, and very <sup>well</sup> <sup>indeed</sup> some has a good crop of Children.

The Indian at the Paulo Affonso Falls, the principal inhabitant and guide, has ten Children. He lost 85 Cows, by the drought, and now he has only 30.

I apprehend that it will be tedious, <sup>to</sup> <sup>work</sup> <sup>up</sup> against the current with such <sup>Canoe</sup> <sup>men</sup> <sup>power</sup> as can be commanded. I can judge better after seeing what kind of Canoes we get, and after we transform them into boats.

In case there <sup>is</sup> <sup>sufficient</sup> <sup>depth</sup> <sup>of</sup> <sup>water</sup> for the Paulo Affonso I would greatly rejoice if she could overtake us, and then aid us in our further progress up the river.

The stream at Jatoba, and here, is wide and beautiful, nearly half a mile, and the river bottoms and slopes at a distance form pleasing pictures; but when <sup>we</sup> <sup>approach</sup> <sup>them</sup>, their beauty fades away and <sup>nothing</sup> <sup>but</sup> <sup>them</sup>, sterility remains.

The natural harbor, <sup>on</sup> <sup>front</sup> <sup>of</sup> <sup>the</sup> <sup>rocky</sup> <sup>river</sup> <sup>fringe</sup> at Jatoba, is a favorable point for connecting the Railway with the river. At its low stage, the river in front is from 6 to 7 meters deep, and the face of the rock bluff of one stands about 5 meters above the present low water surface. The river rises about 10 meters in <sup>these</sup> <sup>places</sup> <sup>on</sup> <sup>of</sup> <sup>of</sup> <sup>no</sup> <sup>great</sup> <sup>account</sup>. <sup>Canoe</sup> <sup>men</sup> <sup>from</sup> <sup>a</sup> <sup>medium</sup> <sup>size</sup> <sup>canoes</sup>.

38) great floods, and the Rail way track will be about two miles higher, so that a structure 7 metres high on the rock bluff face will be level with the track. [The present arrangement has not yet been decided upon by the Chief Engineer.] The rock rises back of the front, and above that is sandy alluvial material.

As the ground admits of a good arrangement, it may be found advisable hereafter to project a break water <sup>of some</sup> out 30 or 40 ft into the river, at a point of rocks a few hundred feet higher up to protect the harbor in high floods. I judge that in high water the great face of the river comes from a point about a mile above on the Bahia side with great face against this rock front at an oblique angle. The water surfaces and holes in the rock show the effects of a powerful current; but it need not be built now or till the Engineer has seen a high flood.

I had written thus far in the hope that our man, Porenia da Andrade, whom Mr Krueger sent to Coaba after Canoas, may report, this tonight or tomorrow morning.

Upon one point I can now speak with confidence: A canal, with locks, around the Falls of Paulo Affonso (and the Falls of Stephanie) <sup>is</sup> illegal & as entirely inadmissible; not only on account of the great first cost, but on account of the annual cost of keeping it in repair, and the delay it would cause to transportation. The circumstances point clearly to a railway as the proper mode of connecting the upper and Lower San Francisco. [Atalho Aug 31. 1879]

Since writing the foregoing I have made a personal examination of the Cachoeira da Vargem Redonda. It is about the 3 1/4<sup>th</sup> league of Mr. Hayfield's map. The swift water at the head and just above the rapids but <sup>comes</sup> Canoas can work through <sup>going up, with the aid of</sup> and the Paulo Affonso could run up without difficulty. The river here is about two palms above extreme low water. We have no wind yet of any canoes from above, nor any news of the Paulo Affonso. I have the honor to remain with the most respect your  
J. M. R.

Friday Aug. 29. Atalho. Ok! 39

I awoke this morning about six, with a miserable feeling of stuffed head - which I ascribe to stuffing my stomach yesterday, and somewhat trotting and some water melon.

I ate a moderate breakfast - (and I had walked around a little before breakfast) The residue of our troupe come in this morning except the Boats, which are to come by an ox-team and big wagons, and we now have all our provisions - and the foreman Gomez da Costa of our 12 men - he being one - who act as our Military Guard, though they are not soldiers.

I devoted the residue of the day when not in consultation with Mr. Meier, Mr Derby and Mr Lisboa to others, about what I wish done here to writing a very long letter to the Minister - Pernambuco - a rough draught of which is in the preceding pages. To write it and copy it too.

4:50 P.M. Our host, or neighbor Jose Manoel de Souza who told us about a medium size canoe a few miles below, has just been to see me and say it has a whole in it, and if that were mended he thinks it would not be suitable for our purpose of taking overlandings; so I suppose we must wait till we get canoes from above.

I decided that measurement of the width of the river should be taken at this place to day, by two methods, partly for the purpose of knowing the width, and to test the instruments; and to give the young engineers practice.

5. P.M. I have felt uncomfortable all day, with a partially stuffed head, and in the morning four bowel discharges. About midday I took a dose of effervescent powder Pyretic Saline (Potash + Soda) which helped a little to clear my head.

See page 44 for conclusion of this letter.

Continuation of the above letter.

The Engineer's letter has not yet arrived, at least I hope so. I have written from the Canoas into order to take advantage of an opportunity of sending it.

40 Saturday - Aug. 30<sup>th</sup> - Atalho.  
 At the friendly Casa of José Man<sup>o</sup>l de Souza  
 in Camp. Last night I retired early. It was  
 quite windy most of the night. I was frequently  
 awake and dreamed a great deal, and my head  
 did not feel comfortable. After being up some  
 time during this morning, and reading Blutten  
 Vol 11 - I have taken another dose of the Pyretic  
Saline. I do not yet (an hour after) feel much  
 effect from it. My head is still stuffer - My  
 bowels are quiet, as yet.

Breakfast about 10 - just previous, I took a second  
 dose of Pyretic Saline, which, with the breakfast, mod-  
 erate in amount, seemed to relieve my head considerably.  
 At 11, I concluded to make a personal examination of the  
 Cachoeira Verzea Rodonda - about a league below  
 Atalho. Sr. Gomes da Castro - our Foreman with us.

Cachoeira Verzea Rodonda. <sup>Mr. de Souza do</sup> <sub>Duffles et.</sub>

This is about the 314<sup>th</sup> League of M. Halfeld, which he  
 calls Cachoeira da Vargem Redonda.  
 M. Halfeld's Map of this Rapids (or Falls as it  
 might be called in high water) is on a small scale  
 and conveys a very inadequate idea of the place  
 as it appears now, when the water is within 2  
 palms (so says Sr. José Man<sup>o</sup>l de Souza, our guide  
 this day) of its low stage; 18 inches above extreme  
 low water.

The rapids from the upper end of the Reef  
 which runs across the river, nearly at right  
 angles, to the lower end at the pool of deep  
 water below occupy nearly a mile. The river  
 itself is nearly half a mile wide above the rapids  
 and quite wide in high water along all parts of  
 the rapids narrowing below along the rocky wall  
 on the Bahia side or right bank, but soon widening  
 to a fine clear navigation, which continues good  
 depth for any vessel that can navigate this river  
 above the Falls of Paulo Affonso, all the way to  
 Satuba, the upper terminus of the railway now  
 under construction.

The river channel above these Rapids is on the

Saturday - Aug. 30<sup>th</sup> - Cont<sup>d</sup>. Atalho, etc. (41)  
 Bahia side - (though there is another channel for  
 light canoes down near the middle of the river in  
 low water, as it is now.

M. Halfeld gives no soundings or current  
 rates at this place, nor any below this.  
 There seems to be a hiatus in M. Halfeld's Maps  
 about here. Sheet No 26 ends at League 321½, about.  
 # Sheet No 27 begins at " 339  
 missing - according to this. \* 18½ \*

At all events there are no soundings or current rates  
 given on any of M. Halfeld's maps that I have, between  
 League 314, above the Cachoeira da Vargem Redonda  
 to near Piranhas about league 339 - along a dis-  
 tance of 18½ leagues.

I understand that this point, da Vargem  
 Redonda, has been considered as the lower  
 end of the <sup>navigability of the</sup> Upper San Francisco - when it has  
 been customary to embark and disembark; although  
 the canoes can run down as far as Jotaba;  
 but have some work to get up through the swift  
 water near the foot of the rapids - and also at the  
 head, on the Bahia side. This, where Captain  
 Buxton ended his interesting journey, and made  
 his adieu to the Upper San Francisco, at the  
 hospitable Casa of Sen<sup>o</sup> José Manoel de Souza.

This rapids, for a  
 kilometer, or more, in  
 length, covers two swift  
 places in low water - one  
 at the head, A - the other at  
 the foot, B. The one at the foot  
 is wide, and deep, a good  
 navigation except that the current  
 is 2 to 3 miles an hour - the one  
 at the head is swift and  
 much narrower, though it  
 has ample depth.  
 A small steamer draws  
 4 or 5 ft water could  
 ascend it safely.  
 The Paulo Affonso  
 can ascend here



The current is strong all the way there but there are colder swifts. Canoe men take advantage of it. But at the upper end of the lower swift they have to cobble to get the canoes past. The only point I am in doubt about to close is the mouth of the upper channel - Man<sup>o</sup>l de Souza says it is narrow not over 20 ft below the rocks.\*

42) Sat. Aug. 30. Atalho and Redonda  
Continu. of Cachoieira da Vargem Redonda

The reefs of rocks remaining substantially the same from year to year, the Channels at any given height of the water remain the same; but the movement of the water and the precise direction of the Current through the natural Channels vary with the varying height of the river; so that the main channel which in a low stage of the river is practicable for the ascent of canoes may not be so in a considerably higher stage.

On low water there is a large area on the Pernambuco or left shore, over which the rocks project with <sup>the</sup> utmost irregularity of height and position, which in a medium or half flood, are overflowed, and which, owing to their rugged character create a violent turmoil in the water. With every added metre of depth the Current becomes stronger, and in high stages of the river only a steamer with the proper power can stem the Current.

Even for descending Canoes a considerable increase in the depth of the flow renders it necessary to be careful and watchful in passing through the Channel.

The river here begins its annual rise about <sup>the beginning of</sup> Nov. It does not rise continuously, but fluctuates, sometimes falling, sometimes rising faster. About the latter part of January, or in February, it attains its height. <sup>the height varies considerably in different years.</sup>

It usually continues at a high stage, without material falling till about the first of April. From that time it fluctuates, (rising or falling); but gradually <sup>to a considerable lower</sup> falling till October, when it is usually at its lowest stage.

In June, July, August, and September, it may be considered to be low, though not at its lowest stage till October, and is good navigation for canoe boating.

Sunday - Aug 31<sup>st</sup> 1879 -

43  
Atalho, Província of Pernambuco -

Mine Ex.<sup>mo</sup> Comendador  
Senhor

Publicas  
João Wilkens de Mattos, Director Obras,  
Rio de Janeiro.

your Office, dated August 9<sup>th</sup> 1879, received here to day. It enclosed the bill of Senr. O. C. James, dated July 31<sup>st</sup> 1879, amounting to 39 \$ <sup>of which</sup> ~~the~~ <sup>most</sup> ~~of~~ <sup>of</sup> the items marked with red ~~is~~ <sup>are</sup> not proper to be paid by the Government.

Before leaving Rio de Janeiro <sup>with the</sup> ~~the~~ <sup>Commission</sup> ~~the~~ <sup>Commission</sup> I understood that ~~the~~ <sup>the</sup> expenses of the Commission, including provisions, were to be paid by the Government.

~~I was not~~ <sup>was not</sup> aware that there was a diário to be paid to the Engineers. ~~I learned that afterwards.~~ I did not know what the <sup>in such cases</sup> ~~Custom~~ <sup>was</sup> and I only ~~intended~~ <sup>intended</sup> to carry out the <sup>general</sup> ~~instructions~~ <sup>instructions</sup> received from Comendador Plinio.

My <sup>policy</sup> ~~course~~ is to conform to the customs of the Government. Is it the Custom to allow a diário, in such an expedition, to the Engineers in Chief?

If so, what should it be. I have <sup>assumed</sup> ~~supposed~~ that the diário of the other members of the Commission will be as follows:

Primeira Engenharia	\$ 8.
Chief de Secção -	7.
1 <sup>st</sup> Class Engo.	6.
2 <sup>d</sup> Class Engo.	5.

another bill, together with the original bill, I enclose herewith ~~and~~ <sup>corrected</sup> in accordance with the marks in red on the <sup>original</sup> ~~bill~~ <sup>and</sup> bill. As all the articles were ordered through Senr. James, <sup>and</sup> supposed to be for government account, there is no way of determining <sup>precisely</sup> ~~what~~ <sup>the</sup> portion of the items marked thus? belongs in the bill. I have <sup>my</sup> ~~assumed~~ it at one half.

I trust that my action will be regarded as satisfactory.

444 Sunday Aug 31. 1879. Atalho.  
Conclusion of letter to Ministro Simimbu.

I close this in order to take advantage of an opportunity of sending letters to Piranhas by the hands of Senr. Cavalcanti, Eng. who to day brought letters to us from Rio de Janeiro. Among them are from Comendador Wilkens Mattus, returning our bill, for correction, and which I am now to day

I have the honor to remain  
with the highest respect

Your obedient servant  
W.M.R. - Eng. in Chief.

P.S. Senr. Cavalcanti  
left before my letter was  
quite ready, and I will  
send this by another person.

Atalho, Prov. of Pernambuco.  
August 31. 1879.

Mmo Exmo

Comendador  
Senr. D. Luiz Plinio d' Oliveira.  
Secretaria de Estado

This morning,

Just after writing my letter to the  
Minister - (upon which I have the honor to enclose  
here with) the messenger, sent by Chief Eng. Knigge  
from Piranhas, I understood that he had  
sent an ~~agent~~ agent, with authority to buy or  
rent Canoes and get them down here to us) but it  
appears that he is only a messenger, and on enquiring  
of him he could tell us nothing definite about  
Canoes in Cabroba. He ~~was~~ <sup>sent</sup> his letter from  
Cabroba in answer to letters which he had carried  
from Piranhas, from our friend Venturo to Sr.  
Fortunato Francisco dos Santos, and Vigario Ant.  
Jose Ferreira de Novas, about the Canoes.

The letters were sealed; but under the circumstances  
I called a Council of War and opened, and with

45  
difficultly had them read, so as to understand  
their contents.

They amount to this: that at that date Aug 25<sup>th</sup>  
there were no Canoes here that would answer  
to be had. That possibly, by the end of August or be-  
ginning of Sept. there might be some few come back  
to Cabroba which were then up the river, but these  
seemed to be no certainly about any thing; and  
the letters suggest that some person with  
proper authority, etc, should go up to Cabroba to  
make the necessary arrangements, for ~~Canoes~~ <sup>or Canoes</sup> ~~boats~~,  
etc.

This is the only thing that I understood  
the ~~agent~~ <sup>agent</sup> ~~sent~~ <sup>sent</sup> from Piranhas were to do.  
However, he was here; and

As I cannot bear to remain here idle,  
I have determined to procure ~~other~~ <sup>some</sup> back-  
animals, in this vicinity, and ~~push~~ <sup>push</sup> ~~up~~ <sup>up</sup> the  
river.

To day some small Canoes have ap-  
peared for the first time on this part of the river,  
since our arrival. <sup>from above</sup> <sup>very few small canoes as we can get</sup>

My general plan, ~~is~~ <sup>is</sup> to send one of  
my staff with a man and a guard up the  
river, with authority and funds to buy Canoes,  
any where along the river, if found suitable  
~~or possible~~ and send them down to meet us.  
I have ~~heard~~ <sup>heard</sup> from the aforesaid Messenger, that  
there are Canoes along the river, ~~within~~ <sup>within</sup> the next  
12 leagues; so that possibly we may secure them  
this side of Cabroba - and <sup>with</sup> ~~save~~ <sup>save</sup> much time.

The river is within two palms of its lowest  
stage and in a favorable condition for  
our operations. Even if our progress  
may be slow for some time it is better to  
be going than to ~~wait~~ <sup>wait</sup>, or to depend upon  
doing any thing through mere messengers.

We have no wood of the ~~kind~~ <sup>at Cabroba</sup> of the  
wagon, with <sup>the</sup> boards for making Canoes  
into boats; it also contains some other things  
which we need <sup>Mr. Knigge thought the best</sup> ~~rather than~~ <sup>rather than</sup> push animals; but he

After the wagon shall have delivered the things at Jacuba, we will either have to take Canoes down to bring the things up, or send pack-animals to push them up.

The days are warm, but the nights are cool, so that in the tents we find blankets a necessity. It blows most of the time, and nearly always up stream; but to our surprise, our friend Jose Man. de Souza says they don't use sails here at all, and never did, and that they don't know how to use them.

I had some sails made in Piranhas, when they told us quite a different story, and fortunately I knew two men who know how to handle - and I know something about handling sails myself.

Upon the receipt this morning of Commendador <sup>William M. P.</sup> Letter returning M.P.C. James bill for Correction, with a large portion of it marked as not allowable by the Government, the Commission was rather surprised. I had not clearly understood the matter it seems. ~~Through I supposed from what was said, that the Government was to be furnished by the government for their expedition, and that we should go to Rio de Janeiro by the same mail with this letter.~~ <sup>Through I have made out a corrected bill, and that we will go to Rio de Janeiro by the same mail with this letter.</sup>

Perhaps some of the articles may have been stricken out of the bill which you had intended should be at the cost of the government. I return the original bill amounting to 3690\$ to Director Wilkens of Mattus along with the corrected bill. <sup>223</sup> Whatever the government cannot allow, we will of course pay to Mr James ourselves. <sup>223</sup> I wish to obey instruction, and conform to the government rules, in behalf of the Commission.

Under the advice of Chief Surg. Krueger, we did not take soldiers; but employed

12 armed men, who will work when work is needed, one of whom is a good foreman. Eleven of them have families, whom Mr. Krueger will attend to during our absence.

We also by his advice ~~paid~~ and that of our friend Jose Man. a purchase animals, instead of hiring them; and it is well that we did so, for ~~we~~ <sup>we</sup> ~~do not~~ <sup>do not</sup> ~~part~~ <sup>part</sup> ~~with~~ <sup>with</sup> ~~the~~ <sup>the</sup> ~~river~~ <sup>river</sup> ~~fixed~~ <sup>fixed</sup> in the river.

We are here in front of a beautiful ruin. It is with your measure yesterday and found to be 750 metres, or 2440 feet. I had estimated it by the eye at 2500 feet. It is only 197 ft. less than half a mile. In places it is over half a mile.

The only obstruction above Jacuba, to this place, and for some leagues above here is the Cachoeira da Vargem Redonda - about a league below ~~xxxx~~. The Paulo Affonso could run up it now without difficulty, although there is a strong current at the head one foot, with a good depth of water.

We are not quite prepared to take a cross section of the river for want of a proper canoe, but the volume of water now passing in its low (though not its lowest) stage is very great.

This is a very important fact, as it encourages the idea that a fair navigation may be attainable at the rapids.

If the rapids are all caused by reefs of rocks, as they are <sup>for</sup> ~~this~~ <sup>the</sup> ~~case~~, the channels will not be fluctuating, ~~when once fixed~~. Many of the rapids on our American river are <sup>they are</sup> nothing but gravel, or sand and gravel, and subject to change in great floods; but I must see a number more of the rapids higher up before forming any general plans. The bars, on this river, so far as I have seen them, are all of sand.



(Commisao Hydraulica) Atalho Aug. 31. 1879.

Letter to Mrs. Senhor. Reynaldo Von Krueger, Engen.  
em chefe, Estrada de Ferro da Paulo Offenro.  
Paranhas,

My dear Sir:

Senhor Cavalcante arrived this morning early with officiers and newspapers from Rio de Janeiro, and a number of letters of introduction to parties up the river, which he has kindly furnished. We feel under many obligations to him. His engagements on the line prevented him from remaining long enough to carry our letters with him.

Just when we were assuming the letters received; your messenger came in from Cabrovia, with letters addressed to our friend Senhor Ventura; but he could give us no information about Canoes. He seems to have acted simply as a messenger. Under the circumstances we thought it judicious to open the letters which are dated on the 25<sup>th</sup> though not rec<sup>d</sup> here till this morning the 31<sup>st</sup>.

In substance they tell us that there are no suitable Canoes there, and obviously they will do nothing till some <sup>one</sup> with authority, to act should go there. There may or there may not be Canoes there about this time. I enclose the letters to Senhor Ventura with an apology for opening them. You will of course see their contents.

I have think of sending one of the Enginemen up the river to procure Canoes when he can. The Messenger said there are Canoes about a point about 12 leagues from here.

Also think of engaging pack animals and working on up the river with our things in that way. We cannot bring the boards from Jatoba, unless we can over get a couple of Canoes or send pack animals for them.

We have heard nothing of the <sup>Colunas</sup> Paulo Offenro, and nothing very definite about the wagon.

I have examined the rapids of Redonde-braun here and Jatoba, partly on horse back, but mostly with hands & feet, over the rocks, and I have no doubt that the Paulo Offenro could now run up through them easily. The water according to our friend Jose Mart. de Souza, is now about two palms above the lowest water of last year - which I suppose was a low season.

When I see the other rapids, about here I can judge what the Chance is for her going up the river, when she is afloat at Jatoba.

Hoping soon to hear of the arrival of the boards, and hoping to get Canoes.

I have the honor to remain  
Very respectfully  
Yours,  
W. M. Roberts  
Eng. em chefe

Letter to Mrs. Senhor. Ventura Jose Martins,  
Paranhas

The messenger who took letters to Cabrovia returned this far this morning, bringing two letters addressed to you; but he could not tell us any thing whatever about what was said or done <sup>concerning</sup> Canoes.

Under the circumstances, and believing that the letters must relate to the Canoes we took the liberty of opening them; a thing we would not have done under ordinary circumstances, and we learn from them that no Canoes were there and that no definite arrangement has been made, and that we will have to send some one up the river to get Canoes.

Marking you for your kind attention I herewith enclose the <sup>boards</sup> letters. I have the honor to remain  
Yours,  
W. M. Roberts  
em chefe

Letter to O. C. James.

My dear Col:

Utalho Aug 31  
1879.

This morning the Hydraulic Commission rec<sup>d</sup> an Office from Comendador Wilkens de Mattus Director Obras Publicas, declaring that more than two thirds of the bid in made and which was rendered by you on the 31<sup>st</sup> July could not be allowed to be paid by the Government; marking in red the articles so disallowed.

Accordingly I have had made out a new bill of the allowed articles amounting to 12438 which I have sent along with the original bill to Sen<sup>r</sup> Mattus, I have also written to Sr. Florio, upon that along with other subjects.

I don't know enough about these matters here to judge how it will end but it looks as though we will have to pay a considerable part of the cost of this expedition out of our own pockets. If Caem of the government don't pay for us well.

The sun has gone down and I am writing in my lamp by the light of the candles - I have so many letters to write that I must hasten to close.

Do not mention any thing about this pecuniary matter - it would only worry her for nothing.

We got no private letters - but newspapers to the 10<sup>th</sup>. Came to Lisbon Dutch as before for the present.

We are all well.

Kind regards to all

Eduardo de  
Frei de Moraes

Yours very truly  
N. Milner Roberts

P.S. I have one letter - today, which you expected from Eduardo de Moraes (Engenhens) but I have not received the pamphlet which he mentions as having sent. I can send it if you have it. I cannot possibly receive his letter till an mail comes which off.

Letter to Dr. Manoel dest. <sup>Antares</sup> Alva  
adm<sup>o</sup> or Creao  
Estrada de Ferro de Paulo Affonso  
Piranhas.

Dear Sir: Your letter

dated August 29<sup>th</sup> came this morning with other correspondence by the hands of Senhor Cavalante. He could not wait for an answer to letters to go with him, and we will send them by another.

Your mistake in opening the office addressed to me was quite natural and I think nothing of it, feeling perfectly assured that it was entirely accidental.

The members of the Commission with myself are all glad to hear from you, and join in sending kind regards to yourself and the other gentlemen in Piranhas.

With much respect

Very truly yours  
N. Milner Roberts.

52 Letter to Senhor. Atalho Aug 31.

Eduardo José de Moraes  
Engenheiro etc  
São Paulo

Dear Sir

Your letter dated 30<sup>th</sup> of July, came to day bringing <sup>with the mail</sup> <sup>bringing</sup> officios from the government requiring immediate attention, and I have only time to glance at it now and get an idea of your wish, before the mail goes.

It is possible that your pamphlet is among a large number of books & pamphlets which I intended bringing with me to read during my travels along this river. Our baggage is partly here and partly on the way.

As soon as I can have the opportunity, I will with pleasure give attention to your study; but perhaps it may not be in time to answer your present purpose.

The project seems to be an important one, and not having seen the place, I could not form a reliable opinion without a careful study of your pamphlet.

I regret that I did not receive your letter before leaving Rio de Janeiro.

I have the honor to remain  
very respectfully yours  
W. Milner Roberts

Conclusion of Letter to Sr. O. C. James  
N. B. Mr. Doby has been kind enough to look through Sr. Moraes' letter and I have concluded that it is better to acknowledge its receipt. I have a recollection of seeing the pamphlet; but I am afraid it is left behind at Piranhas, with others, enough to fill the strong box, then to remain till we return. Please read my letter and forward to him. "May you be long and prosper"

53 Sunday - Aug 31. Atalho.

See back to page 43. For

Letters to Ministro Senimbu, Plinio, William Mathus, Mr. Knieger, Ventura (João) Martin, O. C. James, Manuel de N. Alves Pinhares, Eduardo José de Moraes (São Paulo) Letters to Ministro, Plinio, and O. C. James, in English - the others in Portuguese. Translated by Lisboa and Lavoura.

Write from 7 A.M. till 10 P.M.

Ser. Cavalante was kind enough to leave with me letters of introduction to persons up the river, as follows:

- Boa Vista - Manuel Jacome Bigella d'Carvalho m. d. <sup>Cap. Sapper</sup> d'Boa Vista.
- " " Vicente Ferreira de Carvalho Ventura.
- Villa da Petrolina - Antonio d' Amorim.
- Pilão Arcado - Ant. da Rocha Medrado.
- Barra do Pajizi - Domingos Ant. Rejean.
- Brandon - Fortunato Francisco dos Santos.\*
- Na villa de Cobrabo - Ant. José d' Andrade. <sup>D. Sabellias</sup>
- " " Ant. José Firmão de Novais.\*
- " " Cabrabo (?) José Soares d' Mello Arelins.

To day Ser. Lisboa and Lavoura, <sup>volunteering and</sup> with our friendly host, Manuel de Sargos, as pilot and canoe-man, (at my suggestion) to examine especially the point or question of width, between the rocks of the Upper end of the Cachoeira da Vargem ~~to~~ Redonda. They report ample width 50 or more metres between the rocks, and good depth, with strong current - perhaps 5 miles an hour, in mid channel. They went down to the pool & whirlpool below the foot of the rapids, and returned up stream through the smaller, or Canoe Channel, nearly the middle of the river.

I propose to make a final personal examination of this channel tomorrow; it will require only a little time in the morning to send off the Correio or mail to Piranhas, and to arrange for some one of the engineers to go up the river to buy canoes.

54 Monday, Sept. 1<sup>st</sup> Atalho - Showery -

About 8. A.M. sent off our Courier "Androclá" on foot, with our mail for Piranhas enclosed in one package addressed to Chief Krüger.

Sent a man a short dis. up the river to get price for Canoe there - would not sell - would rent for 1,800 per day. It is a small canoe.

Authorized Mr. Darby, who wished to "geologize" across the river, to hire the Canoe; and the man, if he can get him, temporarily.

To day, Mr. Weiser and myself went in a Canoe with our friend de Souza, and one of our men, who did the, working (sculling chiefly), under the direction of de Souza; the Channel is first on this side, it then trends across toward the Bahia side, as roughly sketched on Page 41.

The water is about 2 1/2 Palms, say 21 inches above the extreme low water of 1878 - Even with this much less depth in the river above the rapids I think the Paulo Affonso could ascend it through my slowly.

The current is between 5 and 6 miles an hour through a Channel more than 50 meters wide and not badly curved.

At this time, which is certainly a low stage of the river, the Paulo Affonso could run up easily.

Mar. de Souza says that the Cax. da Itacutiara is less difficult than this one though of the same general character.

We rounded the river opp. our Camp and 4 1/2 meters in the Channel, and about 2 feet of water over the large bar, nearest to the Bahia side. In low water some of it is bare. There is another bar below, on the Pirambuco side. The Channel runs between these two bars. We worked our Canoe back on the Bahia side - Stopped and walked up to the high bottom. The highest is not flooded, but the water runs in above and floods when it is the hill in big floods, and the bottom then splits good crops

Rough approximation.

Mon. Sept. 1<sup>st</sup> Atalho - Cont'd.

55

Memo from Halpeld's Map - from Jatobá to Cax. da Panella do Dourado (Araticum - a Bahia side - 122. da Pedra on Pern. side). Sheet No 25 - and part of 26 - League 315 3/4 at Jatobá.

1<sup>st</sup> Cax. da Vargem Redonda. L. 314. at lower end of the rapids. Our examinations show that this rapid offers no serious obstruction to ascending Steamers or barges, or Canoes in low water. Mr. Weiser and I went through it to day. How it may be in high water, as yet I can only infer, that the ~~large~~ area of ragged, black, polished rocks, over which the river will then rage, will make very rough water; though, <sup>probably</sup> leaving smooth enough water through the Channel for Steamers; and perhaps <sup>even</sup> good enough for descending floating barges and Canoes, well navigated.

Above this rapids good navigation to L. 310 opp. Ao pé da Serra - with currents at several points as follows: per hour. 2.05, 2.57, 2.46, 2.67, 2.25, near 310 L. opp. Ao pé da Serra

Cax. da Itacutiara at or near L. 309 1/2 3.04, 2.67. at 309 L. a pool 0.75

Good navigation from 309 L. up to 307 L. at Papagaio - Serra do Papagaio = 2 L.

Good navigation from 307 L. to 299 L. = 8 L.

Just below 305 L. (Comdeira - current 2.05.) Other currents beginning near 307 1/2 L. 2.08, 0.55 0.47, Poco, Poco, Poco, 0.53, 1.60 (Comdeira 2.67) 0.53, 1.34, then Sorobade 299 L.

Cax. do Vão at League 298 3/4

# Here, between 296 3/4 and 298 3/4 there are serious difficulties in the river, which will require some days for their examination L. 298 3/4 MISSÃO de São João Baptista de Rodetes. Cascallo. on the Bahia side.

Special Study. The Situation.

I am here, with a large party, which was selected and equipped in view of navigating, up stream, on this river with a steamer, which could carry the party and two Canoes laden with the baggage.

It is obvious to me that the steamer is not likely to be here in time to be of service to me during the present low water season. If I wait till she can get here she could go but a little way up (supposing the rapids to be navigable for her) before the annual rising of the river; and possibly she may not reach here before the rise may have begun.

My <sup>in the absence of a steamer,</sup> substitute, of taking large Canoes, and with boards making them into boats, and hiring river men to pull, or row, or sail them up, was based upon the information that large Canoes could readily be had; ~~and~~ that it was common for them to come to Redonda or Atalho; that they could easily navigate this part of the <sup>Upper San Francisco</sup>; and I was led to believe that such <sup>boats</sup> would be here very soon after we could get here from Piranhas with pack-trains; and that they were in the habit of using sails here as they do on the lower river.

This information is erroneous. I am to day quite uncertain whether we can get any large Canoes brought down or when they can be here; and when here, the canoe men know nothing about using sails. We might make some use of sails with the aid of a few of our men from below who know how to use sails; but even with sails, we cannot, in many places, make

headway against the current. I find already in the Falls of Redonda a stronger current than any shown by Mr. Halsted - namely, between 5 and 6 miles an hour.

The Steam launch can stem this; but Canoes deeply laden, even with a good wind, may not be able to do it, and they will have to be worked <sup>up stream</sup> more or less in the fashion to which the canoe men along this part of the river are accustomed, namely pulling and sculling in the eddies and cordelling them around the swift water, along its edges.

Two or three men, lightly equipped, might ascend the river at a reasonable rate of speed; but this large party, with 12 hired men as a guard (to labor it is true also when necessary) and 5 other men sent to us from Piranhas, now make our whole party  $12+5+12=29$  men. If we have two double canoes of large size, and one double canoe of small size, with their crews, (6 men in each of the large ones and 4 in the small one, according to Mr. Knieger) we should have <sup>only</sup> 40 men - which, without any baggage, would be at least 3 tons. But cutting off 6 of these, then adding the baggage, instruments, and provisions, the canoeing would be so well laden that their progress would be very slow; and I would anticipate that we should have to put off the men (all except the hands working the double canoes up) at every rapid - and possibly we might at some of them be obliged to lighten cargo.

We should of course be obliged to encamp on shore, in any case; unless we had large barges; large enough to make sleeping room for 34 persons. I will now consider what kind of examination of the

56 Mem. Sept. 1. Atalho.

57

river could be made under such circumstances:

Soundings, could occasionally be taken; but only occasionally; because it would be useless to take soundings when the boats would be under the circumstances mentioned most of the time in the eddies, or eddelling along the edges of the Channels.

No regular system of soundings could be taken continuously in the Channels.

Observations of the shores, <sup>course of the stream,</sup> rocks, bars, towns, bluffs, hills, Mountains, etc., could be made by the Engineers on the boats; and Mr. Hatfield's map tested and made serviceable.

Cross Sections of the river, (which, however, would only be needed at considerable intervals, along the river) would have to be made with Canoes of moderate size; which would have to be taken along with the double Canoes, for that special purpose; and which might perhaps be used in making some soundings by running down stream through the Channels - poking them up again, in the usual way.

Meanwhile there would be nothing for the 12 men to except to assist in putting up the tents, and in striking them and carrying them on board again - excepting that they might aid in cordelling the boats up the swift water places, and perhaps aid in rowing.

This guard seems to be deemed a necessity. At all events, I dare not, (with my ignorance of the ways of the people along this valley, many of whom have been great sufferers; for several

years) undertake to dispense with it.

It is useless to refer to how I would have arranged this expedition, had I been informed in time of the circumstances, and the object in view, and allowed to plan it from the beginning.

The problem is, with the engineers, and men, and horses on hand, and with what we are likely to command in a reasonable time, say within a week or ten days, in the way of river craft - what is the best mode of accomplishing the most say during the ensuing two months, and two and a half months of up stream movement?

1. The main point is, to ascertain the low water depth of the Channels at the rapids - as many as we can during the short season remaining; the rates of the currents at those places, and to note what can be done to improve them; especially at those deemed most difficult; all other things become secondary.

2. How to do this most expeditiously is the prime question.

3. One plan is to divide the forces. Myself and the smaller party to go ahead, rapidly, on land; selecting certain rapids for my special personal examination - those deemed to be the most difficult. The other force to work their way up the river, examining as rapidly as they can advance with the boats, the other rapids - also taking such notes as they can of those I may have examined; but not stopping for such purpose.

4. Another plan is for about half the party to proceed by Land 80  
the other half by water - to accompany the boats; and all  
rendezvous together very night - The each party making  
such examination as it case.

5. There is known, another element in the problem: It may  
be important that as soon as possible we should know whether  
at any rapids within twenty or thirty leagues, the water  
is too low to permit the ascent of the steam-launch this  
season. I infer <sup>now</sup> from what Manoel de Souza says, and  
from the number of channels shown on M. Halford's map  
that possibly such a place may exist at the Cachoeira  
do Vao, at the 298<sup>th</sup> League, or 16 Leagues by the  
river above here - but not more than 12 Leagues by the direct  
road.

I this evening to decide to proceed thither at  
once in person accompanied by Senhor Jose Manoel de Souza,  
and Sen. Sabido (Mr. Derby also) to look at that particular  
Cachoeira sufficiently to ascertain the certainty (either  
way) or the doubt - as the case may be, so that I can  
communicate the result to Mr. Krugier with such sug-  
gestions as I may feel warranted to offer in connec-  
tion with the Launch Paulo Affonso. Evening Sept 1.  
The Carpinteiro - who is also a boatman will 1879.

accompany us, and one man with a pack mule -  
We have arranged to start at 9 A.M. tomorrow - to be gone  
3 days - though it may be 4.  
Meanwhile Mr. Weiser will remain in command  
at Atalho and attend to all matters. Boon route.

The improvement to be performed for the  
Uzupen Das Francisco, should have depended  
first on the present commercial <sup>of</sup> reach of the  
valley, and the amount of product, and  
next, to its prospective needs, in view of  
the augmentation of minerals that may  
arise in consequence of improved gold  
discovery means of transportation.

Some Remarks - General.

End of Monday - Sept 1.

62] Tuesday - Sept. 2. I leave Alalho, 4-  
bound for Cap. de Vae.

I start this morning with Sr. Sabera, Derby and  
our friend Jose Manuel de Souza, with Carpintaria  
for Cook etc, and one pack animal to visit  
the Cachoeira  $\sqrt{20}$  - about 15 to 16 leagues  
above here, by the river, but said to be no more  
12 by the road - with about 3 or 4 days.  
The morning is cool & cloudy -  
185 Bas

9.30 start on horse path

10. Road - main.

10.54 Summit 1600 meters above Sea - 345

Alt. Fa Grande

11.20 255 - out of bar

11.52 225 pretty flat - sandy

12.03. Turn off to right (1/3 a half mile) to a  
house to get a drink of water - John Pereira  
long earth dam - vegetables <sup>grown</sup> inside  
where there had been water - still dampness.  
Good soil all around here; and along the  
main road the soil is less sandy.

All that this region needs is water  
A small pool of water is still left - for men  
and animals - when it all dries they dig - a  
couple of meters, and get water. It is a natural  
low swale. a slight saline or briny taste.

In rainy weather a large area is filled. 40 acres  
There is also a well - when they get drier water  
John Pereira. Capimbo.

Sr. Pereira says there are a number of dams  
like this along this region -

This is much better than before reaching Jotoba  
but still - what is - a man supports his family

1.25 295 B. in sight of River - going down 5 ft. cont.

1.40 Pic. Rocks - 1/2 m. from River

1.48 Granite High River 1/3 m. from River

P.M. Part die Red S. Stone

2.00 - at House. Casella - near the River.

Opp. end of Papogato Mountain - a

of the shut down appear under 5 years old.

Tuesday - Sept. 2 - Continued.

PAPOGATO

mass of scraggy, Carey, picturesque - fantas-  
tic, Union Pac. R.R. looking Red Sandstone  
rock - in riding down toward Casella - we  
pass one Castle looking rock  
with a natural window in our  
left, and near by, on our right,  
another very picturesque isolated  
Red Sandstone rock.



Casella opp. at 2. P.M. we halt, at Papogato Mountain  
calling it 4 leagues from Alalho.

I think it is rather less than more.  
We had a fine view of the river for a league or  
more below as it sweeps around <sup>the point</sup> the point  
Cum glaucous radius, lies hidden by the point on the  
Bahia side. By the river the dis. is called (not  
very definitely) seven or eight leagues - Adulfeld calls  
it 4 leagues (about).

Sabreca - above here, where we want to stop to-  
night, Manuel de Souza calls 3 leagues. He says it  
is in the river - Janda road along the river from here to it.

Sr. Amarante was here last night, &  
left at 6 this morning - He arranged, or spoke about 2  
Canoes - one a league, the other two leagues above him -  
Manoel Victorina, the proprietor here (with the usual  
abundance of children of various sorts) says they are only 30  
Palm-logs - only about 20 feet. [Small Canoes.]

We feed our animals here, with Casim; and con-  
clude to cook our dinner and eat it here, and ride the  
3 leagues afterward. A clear navigation below as far as  
I can see for the bond

The Red Sandstone Rocks here have a peculiar  
aspect. Manoel de Souza says that Tigers formerly in-  
habited some of the Caves. He also says that a few  
years ago a high pinnacle of the rock, owing the action  
of the rain fell, with a great crash like an earthquake.

The most picturesque view of the ending of this  
rocky ridge cannot be seen from the river; though the  
aspect of the river part is very imposing. Casella



after stopping about 2 hours, and feeding our horses, and ourselves at the house? Built in the usual style of the country, with a very strong up river wind (in our former we remembered and started for Sabuca at

5 P.M. The river along here is over half a mile wide, and the Bahia side reminds me of rivers along the Selmau below Bristol. It is a clear river for a league or more above here on the long coast on this side. The forest about 1 1/2 miles above on the Bahia side hides the residence of the river on that side.

Arrive at Curuata - (about a league below Sabuca) on account of Capim for horses.

Large men - women, mother, daughter + sister (Col Indian) woman of the Camp - bed + Sr. Saboia's Hammock

Sleep in one end of the usual house mud + thick.

Children plenty - wide handsome river - all along

has alluvial soil - gently sloping away from the river

needs only water to make fertile land. Horses along the river banks are not over 1/2 mile apart

a.m. Wednesday - Sept. 3<sup>d</sup>

Start - 5.05 from Curuata -

Same alluvial slopes.

6.10 Roads fork - one goes along up river - the other cuts across - we cut across

7.10. Barometer 230. 245

Soil changes to granitic - surface covered with numerous stones.

7.45 Cross PATAU river - a large dry bed 500 to 600 feet wide. After passing this, we see many of the alluvial bottom. I see water in the river 1/2 mile below.

8.30 Stop on the river. No one at the house. We now go again along the customary sloping river bank or high bottom - clayey alluvium.

8.45 We strike Jacurubá (a house) and arrange to feed the animals. They make salt here out of the clay - about 2 cups out of a bag + bucket of earth.

These names, that seem like names of towns - merely designate a stretch, or place along the river - One house is much like another - one family like another - only here we see the best work of civilized savages. a Pig. 54 1/2 cat old.

Yesterday and to day - after striking the river, we find the soil quite different from the hard gravelly and sandy soil below Atalho. It is a clayey alluvium, which needs only water to be very fertile.

The river itself which contains abundance of water affords power enough in its flow to force up water upon nearly any plantation. The wind which blows strongly two thirds of the 24 hours gives a power that would do the same thing. These lands at the river are generally a little higher than the highest floods - they then descend very gradually for about half a mile back to where the land is inundated in years. With rain, more evenly distributed, these high bottoms would make grand farms without irrigation.

I have been to day a little above the 298<sup>th</sup> league - or 16 leagues above Atalho.

Little island this side of

There are two small reefs on the opp. side of the S. Antonio island - One near the upper end, 25 ft wide, about

4 ft deep now - 4 to 4 1/2 ft above - 100 yds below <sup>15 to 20 ft wide</sup> another (6 or 8 inches fall each) which has at least 4 1/2 feet now and which with some help the lands could go up.

The water falls here to about 3 ft depth. Then the lands could not go up.

But in a year or two, there is deep water on the Bahia side; bad for descending boats - which cause them to take this side of S. Miguel island.

At the lower point of the island the channel is confined to about 20 feet width - where there 3 rocks are about each other bounding it - It makes a good channel now for the Paulo affore. It is cheap work to concentrate these three little rapids - the water into a single good channel 4 or 5 ft deep in low water - at present there is over 4 ft.

Along here out of the Earth. Water and Evaporate.

SALT is made

Start at 12:35 - down river - at 12:50 - see two rapids between us and the little island which may be trabacum. The Channel is on the island side of this arm and 400 ft. wide - The two rapids about 400 or 500 ft. apart - a dam 300 ft. long left high 10 ft wide, under dam the water in the Channel at the upper falls - 17 ft. fall and 2 ft. in 200 - the lower one of the two a dam 200 ft. under do the same. This is the ugliest looking place I have seen on this rapids; but there is nothing terrible about it. I think that with some help the Paulo Affonso could go up now - but in extreme low water it is doubtful whether she could see the water shall be concentrated.

The lower one of these two is the hardest looking Channel I have seen; but I think that now there is a Channel about 10 ft wide with a pitch of  $1\frac{1}{2}$  ft. in 100 - and probably as deep as 4 ft. so that with the aid of six men the launch could be put through but with the water 12 to 18 inches lower it is doubtful whether it - 2 ft. fall is below is another swift, but it is 20 ft wide and a good depth.

(Cachoeira)  
2.00 P.M. do Vão.

3 Rapids - The lower one of the two is the only one I am in doubt about - these two rapids are very favorable for crossing.

2.30 - We stop at Sr. Domingos Ant<sup>o</sup> de Resende friend of José Manoel de Souza - who is with us.

We learn that Mr. Amarante bought on canoe from his brother across the river 54 Palms long, and that it will start down to Abalho tomorrow.

I conclude to go across this arm of the River to the foot of Sobrababe island - which is just above this Fazenda - and walk up a mile or thereabouts to the Cachoeira do Vão. Mr. Amarante, Derby, de Souza and I were taken over by the young man - We walked up on this Abalho island. The elevation of which is near that of the highest floods - it is not all overflow, and most of it only to a slight depth. It is a splendid place for introducing irrigating farming. There is here abundance of water power to throw up all that would be needed for supplying a magnificent farm.

We cross over in a canoe from Sr. Resende's magnificent Caraiqueira tree, on the River bank to the pt. of the island. We start at 3:20 and arrive at the Falls of VÃO 3:55 - with but little pause. We stopped  $\frac{1}{2}$  mile above foot of island to look at large gravel bar, which fills the river, obliquely, to the Channel on this side - which at present is deep enough for the launch - but is not deep enough in low water.

3:55 - at the Falls VÃO - a regular line of irregular heights of rocks, length N 75 E - about 900 to 1000 ft. in length. The right angle of the river from the island end of the reef is narrow claw of 570. E (about) The water is only 20 inches above low water!

At this time, the Paulo Affonso could not pass this falls afloat. There are many little channels; but only one now fit for canoes to pass. It is close on the island side, about 8 ft wide - with a pitch of 2 ft in 20 ft (and  $1\frac{1}{2}$  in 10 ft) and the launch would certainly stick. She would nearly clear this little channel, and the water under in a little and flow over the rocks on each side of her. In low water it will be even worse. She could not reach this falls.

This one we wished in the afternoon to go in a canoe to the low point of the island by Sobrababe. This time island belongs to Dom. Ant<sup>o</sup> de Resende.

The young man who came with us says that this arm of the river can be passed in October - Con- formed by our friend Manoel de Souza.

There is now a large body of water flowing in a dam this arm of the river; but it is further and across this reef in perhaps 20 little useless channels or falls - within 50 ft of the channel referred to nearest to the island a large stream passes, but it has a nearly vertical fall over the rock dam of 2 feet and a canoe cannot safely pass there.

If this arm of the river - should be the one selected for improvement, the plan at this Falls or reef, will be to build low cuts both to the rocks entirely across the reef leaving only one place say 50 ft wide which should receive all the water at a low stage, and also to blast out some rocks - perhaps a hundred or two hundred c.y.d. when this 50 ft channel should be made - and cut it so as to make <sup>side</sup> guides for the channel.

There are two places - one near the middle and one near the island, to be looked at for this. At the same time the bars below and the reefs above must be improved, or this work here would be mostly thrown away.

Every thing being prepared before hand the work should be done in Augt. Sept. and Oct. - a moderate force of American hands would do it all in that time or less.

I see plainly however, that more work is required than I was inclined to assume when I examined the upper reefs this morning.

The Bahia side of the river must be carefully examined next - as there is much the largest body of water runs, at all times.

One point is now settled I must state that the Paulo affonso cannot pass this fall until the rise in November -

300 ft. below the Falls, is a reef just now striking a little out of water - that could have to be treated in the same general manner; but it has not over 6 to 8 inches fall but nearly or quite the same length (a crooked nearly parallel line with the Falls -

A 4 feet depth is practicable to be had in this arm at a cost which I can estimate approximately - It must be compared with the Bahia side.

4<sup>o</sup>. 45<sup>o</sup> P.M. -

our walk back on the island a straight course occupied just 30 minutes, and we walked more than 3 miles an hour, so that the distance by the river arm is  $1\frac{1}{2}$  miles. from the Cachocra do Vao to the lower point of Island Sorobabe.

We have arranged to feed our animals and eat our dinner here, and remain overnight in the house of Domingos Ant<sup>o</sup> de Rezende.

walked 5 miles to day!

After satisfying myself that it is impracticable to take the Cachoeira Paulo affonso up the river through this arm on the Pernambuco side, I resolved to examine the Bahia side - which is the main stream; where runs the larger body of water passes, which will probably detain us one day longer away from Atalho.

The plan is to take the large canoe, which Mr Amarantho had arranged to start to day for Atalho, and push it up to the Falls on the Bahia side. If that is found impracticable for the launch (before the main rise,) then to accompany (go in) the canoe with Mr Saboria, and our baggage down the river, while Mr Dury and Manuel de Souza, go on horse back about the Mountain. and our bodies will take the horses back to Atalho. A Good day's work!  
Sorobabe!

Had the best sleep I have had in the field. Awoke about 5 $\frac{1}{2}$ , but did not rise till 6 - till then was movement in the house. Our Canoe has come across the river from the Bahia side, and is ready for us.

The river here is, I think, a full half mile wide - just below the island Sorobabe, and for several miles up and down it is a beautiful stream.

Our canoe is 54 palmos = 38 feet long. It is a very heavy, clumsy thing; but we could make it answer with another like it, as an arajo.

8.08. Stop canoe - get out and walk over the rough, black, semi polished rocks to the first bad Falls - when the fall is thick about 6 ft in 400 - but owing to some rocks, forming half cades I think a Columbia River steamer could pass up to and less than four miles higher up, is the upper of these two bad falls, which falls about 4 ft in 200

arrived at Upper Falls at 9 a.m. - observed thro - and leave 9-15-

BAHIA-SIDE CHANNEL.

- A. Pishes 3 ft in 50 - nam 20 ft clear deep. <sup>navigation</sup>
- B " 4 ft in 100 Camille the bulk of the river
- C " 3 ft in 200 C. is the place I am

inclined to select to make a steamboat navigation 30 arms 2<sup>d</sup> time at lower Falls - at 9<sup>o</sup>.22.

At the lower Falls, I am inclined to adopt a similar general plan - to eschew the main flow, for the low water channel, and construct it with cribs filled with stone (of which abundance of the night land just here) on the left side where there is at present a narrow channel. A few rocks might have to be blown out in order to complete these low water channels.



Below the lowermost of these two falls, the Steamboat navigation on the way from Sorababe - 2 $\frac{1}{2}$  miles or so is as good as the navigation within a few miles of Piranhas - no work is required on this part of the river. [The present result

of my examinations of these Falls - on the left shore, arm, and on the main river, is, that it is impracticable, with now, to take the launch up past these Cachoeiras; and the evidence is clear that the level of the surface has got to fall at least 2 palmos, which in this case will make it materially worse.

I regard it as barely practicable to get up with a loaded Arajo - or even large Canoe. A large Canoe here, is about 35 to 40 ft. long, 2 feet wide and drawing a foot to 15 inches water.

I had intended going down the river with this Canoe - but they talk about being 3 or 4 days, and I cannot bear the waste of my time in that way. So we will pack up, and turn homeward with our animals.



I leave the lower falls at 9.35 -

Returned to the Canoe at 10.12 and start homeward at 10.15 - with a pretty strong wind against us. High water made of 1879, on the rocks is only 10 to 12 ft above present water. It was a low flood. Floods begin to pass in March. The whole width of this arm or branch (main body) is perhaps 1/2 a mile wide in a flood. at present it is only 1000 or 1200 ft of water and as it is only 400 ft wide a strong current - but my deep. we begin to go down with the current at 10.24 - at 10.57 water clear to pass

Son's Castro + Recreio  
 Swelled and Singing  
 This portion of the Bahia  
 Channel - Sept 19 + 20.  
 I verified by leveling  
 about 2 1/2 Kilometers -  
 Sept. 21<sup>st</sup> 1879 -  
 See Journal Sept 21.

September 21 - 1879 - See Journal

See page 74.

Letter to Dr. Luiz Plinio d'Alveira  
 This letter is changed see page 79.  
 Don't expunge.  
 Finding that several days must elapse before we could receive our boards <sup>and off the canoe</sup> from Pernambuco, for arranging our Agoios to carry us up stream, I took Mr. Loboia, and (Mr. Derby volunteering) and, under the guidance of our friend, Manoel de Souza, started on Tuesday, Sept 2<sup>d</sup>, on horse back for the Cachoeira do Vão, in order to decide, from personal examination, whether the launch Paulo Affonso could pass up through it. This we can, before the annual rising of the river; and also to study these rapids, which Ingenheiro Halsted, and Krauss, pronounce the most difficult <sup>of any</sup> on the river above the Cachoeira Stapanica.

The Cachoeira do Vão - the main fall, is about 15 leagues to the river above Halsto; but we visit a league <sup>and see all the intervening falls, and higher up, as to see the upper rapids on the Pernambuco side, and then examined each fall or rapid, down to the lower end of the Island Sorababo, (at the fazenda of Sr. Domingos Ant. de Rezende, who made us welcome at his comfortable home, at the beautiful tree Carabeira, one of the handsomest trees I ever saw - and the finest I have met on this river.)</sup>

After examining the several Cachoeiras on the Pernambuco arm of the river, partly along the main shore and partly on the island Sorababo - which we reached in a canoe; we got another large canoe, and pushed it up on the Bahia side as near to the lower falls as it could go, and then walked on the rough black rocks to the lower falls. There are two about 200 meters apart.

The launch Paulo Affonso cannot pass up at this time, on either side, and the water has got to fall at least two palms, to two and half palms. She cannot be taken past these falls, which cover more than a league in length, till the river shall rise, which will not be here before November; and not in time to be of any service to us during our present season's examinations.

I must so report to Chief Eng. Kreiger. He will act according to the orders from the

government. If the Government desires to have the launch transported on land to Jotoba, independently of any service this steam with the Hydraulic Commission, I can of course say nothing; but if the Government expects me to be able to avail myself of its aid in ascending the river, I must state that it cannot be done. is not practicable <sup>of course</sup>

I am not yet prepared to make any suggestions in regard to the kind of steamer to be used on the Upper San Francisco. I have, indeed, I am inclined to think, from what I have already seen that the American model, of light draught, stern-wheel steamboats, is just what is needed, and which will be found most advantageous. Such steamboats can carry 120 tons of freight without drawing more than 3 feet of water - a boat about 100 feet long from stem to stern, and 20 feet beam; which ought not to cost on the Ohio river more than \$15,000 complete. I think I could have such a boat, <sup>built, which</sup> could be framed, taken apart, sent in pieces, which should not weigh more than two, or at most 3 tons for the larger parts, delivered by a vessel at Piranhas ready to be shipped, and taken over the Paulo Affonso Railway as soon as it can be opened <sup>or even hauled over</sup> the wagon road.

Such a boat could tow barges each carrying 100 tons, up the improved San Francisco, upon a depth of 4 ft. in the river at low water; which, with the large volume of water in the river, can probably be secured during the driest part of the driest season. Possibly, at the swiftest rapids, she might have to make two trips through the rapids if she had two loaded barges in tow going up.

I believe that such a steamboat could be <sup>delivered and</sup> together complete at Jotoba at a total cost <sup>of about</sup> \$25,000 - in less than one year after giving the order.

The launch Paulo Affonso has a shape not at all well adapted to the Upper S. Francisco.

74 Thursday Sep 4 - Cont - from page 71 - in the River

We went in to show on the island about 1/4 mile above our house - to pool at 10.37 at 11.05 we arrived <sup>at</sup> 1/2 mile in 41 minutes.

### Sorobabe.

We then breakfasted - discussed the pros and cons of going down river with the Canoe, and decided not to go.

Ordered the horses to be made ready for a start: but Mr Dorby and Manoel de Souza will make their trip <sup>the night</sup> over <sup>the night</sup> "Poco de Cabo" (meaning Well fenced)

### Sen. Dom? Ant. de Rezendes.

1. P. M. start - from Sorobabe for Curuata  
2 miles out we stop 15 minutes for pack animal
2. 05 Cross the dry bed of Pagai River - farther down than where we crossed it going up - 2 plantations here wholly on the bed of the river - raising Corn, Sweet potatoes, melons, etc - <sup>on both sides of the Pagai.</sup> <sup>inhabitable gravelly stream region</sup>
- 4.00 Sabuca: Stop and get a good drink of river water. Here we have crossed the big bend and are on the river bank again -
- 4.35 For several miles we have again had the Alluvium - Alluvial, high bottom.
- 4.35 Cross the dry bed of a smaller river - bed filled with the sand washed down -
- 5.00 Stopped at house on River bank where Sen. Amarante had made some arrangement about 2 Canoes - We went to the river and saw the Canoe. It is a fair median Canoe, for this river - 27 ft long - 89 Palm - long - about 2 ft wide -

5.35 - About a mile or so below the Canoe, we stop for the night, at Curuata - the same place we stopped at on the night of the 2<sup>o</sup> inst. on our way up. Compared with some we have met on our travels above here, these people are quite civilized.

We can see the Papagoia Mountain from here very distinctly bearing S. 35 E. We look obliquely across the river to seeing to a heavy bend in the river below this, to the right. It first bends here coming gently to the left - then straight about EAST for <sup>about</sup> ~~about~~ 3 miles and then curves head to the north on a heavy bend.

Friday Sept. 5<sup>th</sup> Curuata to Caximba to Breakfast - 75  
Mr Dorby and Manoel de Souza - Start for Poco de Cabo  
about 5.30 a. m. - after all hard Coffee.

- AM.
- 5.45 Start for Curuata - Cool but not cold - cloudy - which thins to rain - not heavy - Umbrella up.
  - 6.20 Dry, small river
  - 7.20 Cascella - We pass without stopping - Some soldiers here, with Cornets going to Pernambuco & Pernambuco.
  - 7.35 Castle with windows - The fantastic rocks Sign Caves in the main Mountain Ridge
  - 7.45 1<sup>st</sup> Summit of Papagoia Mt. Red Sandstone Heavy Land, up hill road over a mile.
  - 7.55 main Summit, about 2 leagues from Sorobabe - Heavy sandy road - not so heavy as ascending from Cascella - Continue, with scarcely an intermission.

8.50 - We strike the road leading into Caximba (a place with the reservoir, where we visited on our first day out from Atalho.)

8.57 We reach the house, and alight at the invitation of Senhor

9.08 Our Pack-train (consisting of one little gray horse) arrived in charge of Manoel - the Carpenter & Cook for this voyage. Here we are to breakfast and rest. The rain has ceased, and the friendly clouds keep off the heat of the sun. It is very pleasant here.

Goats abound at every house

If I have omitted mention of it, I will now mention, that during our trip of nearly 4 days, in every house where we saw the inhabitants there was one, but generally two or three from 2 to 3 years old always perfectly naked - night and day - all have large bellies - and short legs compared with the length of body - And all are dirty all over.

Washing seems to be relegated to some gala day.

Here Sen. <sup>the milk</sup> has just milked a cow for our use, at the instance of Sen. Sabora. The yield is about a quart and <sup>or less</sup> a pint. There are quite a number of Cows & 4 milk cows, and other cattle.

26 Friday Sept. 5<sup>th</sup>

Caximba

A queer piece of engineering about 200 ft in length at one end is about 5 ft higher than the remainder of the embankment - and the water would flow out over the natural surface at S. before it would rise to near the top of the lower part of the embankment. The upper 5 ft of the high part (or rather 5 ft of its base) is waste work - for all the ground at and beyond S. is as low as at S. But they collect a considerable body of rain-water.

At present the small hole where the gut water is about 15 ft below the bottom of the valley - they follow down as the drought goes on - they say that they have never been without water for the animals.

This Reservoir - seems to be all that renders this place habitable at present - and all the farming that is visible is in the bottom of it, after the water has evaporated (and perhaps some of it seeped away and become lost to them).

The main dependence is the sertão for cattle pasturing and the reservoir for water.

Farming, as we understand it, is not here, nor any where else that I have yet seen.

When the sun shines out clear of clouds the evaporation is very great.

Finish Breakfast at 11 A.M. a very good one. I see here this morning the very image of the Egyptian or gypsy girl (in wax) that was in the window in Chestnut St. Philadelphia - tattooing the figure of the tattooed man - eyes, hair, complexion, figure. There are two sisters here, who if they were cleaned and handsomely dressed would be Christy beauties, notwithstanding their olive complexions.

Industry

Our son-in-law here is a shoemaker - a good pair of slippers Kid-Skin shoes 1.8000 - an elegant tanned large goat skin 1.8000. They don't seem to value their time at any thing.

Friday Sept. 5 - Continued - Caximba

27

John Pereira de Barros

at 2.00 P.M.

We left Caximba - at 12.33. - arrived at the summit of the range, along the heavy sandy road over grading varying from 1 to 3 1/2 per cent - smooth, regular surface line and long straight - a charming bed for a rail road - on both sides of this - I call it a league and a half to the summit from Pereira's House - thence to where the side road for Manoel de Souza's takes off <sup>on a league</sup> I make it 3 leagues from Pereira's to de Souza's - We arrived at Souza's at our ENCAMPMENT at 3.30 P.M.

Find Sr. Cavalcante here with letters from Mr. Torrey, Mr. Senham & Mr. Lobato - offering the services of Sr. Cavalcante to aid us up the river.

We dine - at 4 P.M.

After dinner I proceed to answer the letters - and I hand them around in English to Sr. Lisboa to be put into Portuguese at 6 P.M.

The news is that the wagon with the boards and other things arrived at Olho d'Agua - 3 leagues out from Piranhas only on the 3<sup>rd</sup> inst, have not started till the 1<sup>st</sup> inst. from Piranhas.

Ser. (Copy) At Olho Sept. 5, Evening  
Guariliano da Silveira Sabato. (Cousin)  
Chefe of Secção, Paulo Affonso Railway

I am obliged by the rec<sup>d</sup>. of your letter dated Sept. 4. old<sup>d</sup>. (by the way) to me just now on my return from the Cachoeira do Vão, and I thank you for your kind offer of the services of Sr. Cavalcante. I have no doubt that it would be agreeable to all to have Sr. Cavalcante with our party; but I do not think it is necessary; he has given me letters to his friends up the river, for which I feel under obligations, and I will not fail to deliver them if I can meet the gentlemen. Thanking Sr. Cavalcante and yourself I remain etc W. M. P.  
an. chefe

Reinaldo von Krüger  
Engº em Cheff. tv.

I have rec<sup>d</sup> by the hands of Sr. Cavalcante, your kind letter of the 3<sup>d</sup> of September, for which please accept my thanks.

I have just ret<sup>d</sup> from a personal examination of the Cachoeira do Vão, which I made partly in order to ascertain to a certainty, whether the steam-launch Paulo Affonso could pass up the river through the Cachoeiras at that place.

I carefully examined a league in length on both sides of the river, including the chief difficulties, and I have to report that it is not practicable to put the launch through or past that place until the annual rise of the river in November. The water is now gradually falling. It is still two palms, or perhaps two and a half palms above extreme low water; so that it is daily getting worse.

I wish to telegraph to Sr. Plinio as follows:  
Atalho, Sept 5.

"I have personally examined Cachoeira do Vão, and respectfully report that the launch cannot pass there until the annual rise of the river in November. She cannot aid us in ascending the river this season."

Please bear the above telegram with my name attached sent by the first opportunity.

I thank you for your kind offer to allow Sr. Cavalcante to go with our Commission etc. I am already under obligations to Sr. Cavalcante for letters to friends of this up the river, and I do not think it will be necessary for him to go.

The delay of the boards and parts of your instrument is unfortunate. But I know that you have done all in your power, upon my short notice, to facilitate the movement of the Commission.

I see very plainly that the circumstances of the country and the river at present [p. 92]

Telegram

I have carefully examined Cachoeira do Vão, and respectfully report that the launch cannot pass there until the annual rise of the river in November. She cannot aid us in ascending the river this season."

Letter. Atalho Sept. 5, 1879  
Comendador, D. Luiz Plinio  
d' Oliveira - Secretaria de,

I send at this date the above telegram to Chief Eng. Kruger at Piranhas requesting him to have it forwarded by the first opportunity. It is sent in Portuguese.

I returned this evening from a four days horseback journey to the Cachoeira do Vão - and the other Cachoeiras in that vicinity, which I examined during most of two days on foot and in Canoes\* till I was fully satisfied that it is entirely impracticable to pass the launch, in any day, up those falls and rapids until the rise shall rise in November.

The water is still 2 to 2 1/2 palms above extreme low water, and gradually falling, so that it is daily becoming worse for a boat of the build of the Paulo Affonso. She is not well adapted to navigate the Upper San Francisco.

(With the river improved, the most advantageous boat will be something after the model of the Ohio river, or Upper Columbia river, light draught, stern-wheel steamboats; suited to towing barges, and also carrying some freight herself. In due time I can give you particulars about these boats.)

\* I was accompanied by Sen<sup>or</sup> Sabria & Derby and our friend who lives here Sen. Jose Maria de Souza



Continuation of letter to Com<sup>d</sup>. Dr. Plinio.

Without some explanation the statement that the launch (drawing 4 1/4 feet) cannot pass the Cachoeira do Vão at this stage of the river, might convey the impression that there is not water enough flowing down these falls to create a navigable depth of 4 1/4 feet. <sup>But it is not so.</sup> There is abundance of water <sup>at the lower part of the river</sup> to make a navigation more than that depth; but it will require considerable labor for several months, <sup>and my examinations are not yet complete enough at this point (see Sheet 25 of Halfeld's report)</sup> to enable me to determine exactly how the improvement should be planned.

I want ahead to <sup>above</sup> ~~the~~ place to ascertain, as soon as possible, whether the launch could be passed, and also to make a preliminary examination of a series of Falls, which M. Halfeld and C. Krauss, both engineers, pronounced the most difficult on the Upper San Francisco.

I am now glad to know, <sup>or hear</sup> that they so pronounced it. That is, I am pleased to think that there is more word about it; because I <sup>think</sup> that a navigable channel can be made here which <sup>and descends</sup> ~~can ascend~~ without a very large expenditure; but I must examine farther. The difficulties are confined chiefly to about a league in length. I examined the channels on both sides of the river. The Bahia side, <sup>has the heaviest falls</sup> where the larger (much the larger) flow is, at all stages of the water, is not used at all by the canoes navigating this part of the river. They all pass from the Bahia side over to the ~~canoe~~ <sup>smaller branch</sup> on the Pernambuco side. Either side can be made into a Steamboat Channel.

Continuation of letter to Com<sup>d</sup>. Dr. Plinio

I am still at a loss for propou Canoas. Senhor Amarante is up the river engaging Canoas. I saw two yesterday that he had engaged - the larger one was to start yesterday afternoon. It was 15 leagues above here, by the river, and it would be 3 or 4 days getting here. The wind blows up stream.

I will probably vary my original programme, by taking a small pre-Limerian party with me, and pushing up the <sup>on home back</sup> river to the other bad falls of Sobrinho - looking at others on the way; having the Projecio Eng<sup>o</sup> and the Chief of Seccao and <sup>assistants</sup> follow up with more critical examinations at the difficult places. In this way we may accomplish something.

The Canoe movements, along this part of the Upper San Francisco are very slow. In fact there was no movement of Canoas going or till now, and there is scarcely motion yet. The <sup>ordinary</sup> facilities, that I have seen in all other rivers, are not here at all. I understand that things are better higher up the river.

The Country is better above here than it is below; but the people, all along the river, and for some miles back, opposite the 16 leagues above here that I have seen, raise hardly enough for their own consumption, and there is no enterprise among them. Concerning this, however, I will write more particularly hereafter.

Sen. Cavalcante is here to night and will take this in the morning on its way to be mailed by Mr. Rodriguez, who has I believe done all he could to aid us; but the circumstances of the Country & of the river are sadly against rapid movement of any kind. We are all well.

\* This <sup>country</sup> ~~country~~ has capabilities - to be referred to hereafter

On the 3<sup>o</sup>. inst, the wagon with boards, and other things was only at Alho d' Agua, on its way to Jatobá.

All the members of the Comm. are well, and anxious to be doing something they can do until we can get proper Canoes here to carry the party.

My experience here this season will prepare me to be an adviser in connection with another season's expeditions along this river, as to the mode of going about it. This will be something gained.

I have the honor to remain  
with the highest respect

Your obt. servt

M. M. R.

Engenheiro

On the morning of Sept. 6<sup>th</sup> Senhor Cavalcante took three letters, together with one to O. C., James endorsing me to my wife.

Sr. Amarante's first canoe arrived here on the morning of the 6<sup>th</sup> (and in the evening the other one came). He came also, but returned in the afternoon to get 2 more smaller canoes 6 leagues above here.

Given Came with the 2<sup>o</sup>. Canoes whom Sr. Amarante had engaged.

Sept. 6<sup>th</sup> 1879.

314- Atalho.

Leagues

298 <sup>3</sup>/<sub>4</sub>

298-

297 <sup>3</sup>/<sub>4</sub>

297 <sup>3</sup>/<sub>4</sub>

297 <sup>3</sup>/<sub>4</sub>

297

296 <sup>3</sup>/<sub>4</sub>

296 <sup>1</sup>/<sub>2</sub>

295 <sup>1</sup>/<sub>2</sub>

294 <sup>1</sup>/<sub>2</sub>

294 <sup>1</sup>/<sub>2</sub>

294 <sup>1</sup>/<sub>2</sub>

293

293

292 <sup>1</sup>/<sub>2</sub>

292 <sup>1</sup>/<sub>2</sub>

291 <sup>3</sup>/<sub>4</sub>

Minor arduous falls to beginning at do Yão.

do Yão - 1 <sup>1</sup>/<sub>2</sub> mile above Sarobabe.

Rx: Espinheira - 1/2 mile below upper end of I. de S. Antonio - saw Sept. 3.

Cax. do Tacarúba - which I have seen Sept. 3.

" Porto Velho

" dos Cavallos

" de Serra Otho -

" de Rodellas

" do Cortume,

Jatetan de baixo

Bar on Bahia side -

Bar on Bahia side -

Bar on Bahia side -

Bar on Bahia side -

Bar on Bahia side -

Bar on Bahia side -

Bar on Bahia side -

Bar on Bahia side -

Bar on Bahia side -

Bar on Bahia side -

Bar on Bahia side -

Bar on Bahia side -

Bar on Bahia side -

Bar on Bahia side -

Bar on Bahia side -

Bar on Bahia side -

falls to beginning at do Yão.

(Saw Sept. 3.)

All on the P.

members side.

mem. the Bahia side I saw the

main falls, opp. the island Sarobabe

in Bahia side - below when the Canoes turn off to river com.

" " When the Canoes turn off to river on the Bahia side,

shows rocks on P. side and only 8 palms (Shallow) on Bahia, otherwise

shows rocks just above on Bahia side also. This is opposite to

Jatetan de baixo

Bar on Bahia side -

Bar on Bahia side -

Bar on Bahia side -

Bar on Bahia side -

Bar on Bahia side -

Bar on Bahia side -

Bar on Bahia side -

Bar on Bahia side -

Bar on Bahia side -

Bar on Bahia side -

Bar on Bahia side -

Bar on Bahia side -

Bar on Bahia side -

Bar on Bahia side -

Bar on Bahia side -

- 291 1/2 Cax<sup>a</sup> do Imbuicão - Bahia side - 3.20 M. Current 30 to 40 P. depth
- " da Missão Short dis. above the other falls - ditto, ditto.
- 291 1/3 Riacho da Pedra d'Água 18.17.20 P. deep - just above ditto, ditto.  
Above this the Channel continues on the Bahia side to L. 287 2/3 when it runs across from the Pernambuco side at L. 287
- # do not deem it necessary at present to go over myself to the Bahia side along here; but to push on to the 287 L. Manoel Aranha (Map.)  
Cax<sup>a</sup> do Borandão, and Cax<sup>a</sup> do Graú, do not seem to amount to much.
- 286 3/4 Cax<sup>a</sup> do Caxauhy - opp. I. do Caxauhy. There appears to be plenty of room outside of island, with 4 1/2 M. Current; but river (on map) is dotted with rocks. Note this place # near Pern. Shore.
- 286 1/2 Cax<sup>a</sup> do Zatoqui - near Pernambuco Shore just above.
- 286 1/4 " Mocó, opp. I. da Boa Vista - Soundings are given on the island side of channel - close to - Current 2.67 M. Caxoecas shown all over the middle of the river, and no Channel line. Estrait of island near Ilha da Vargem a Caiçá one on Bahia side from 287 1/2 L. up to 284 1/2 L. A right angle bend on the Bahia side. Several Cax<sup>a</sup> marked in the Grand or arm on the Bahia side.
- 285 1/2 River narrows; but is my deep 50 to 130 P. Current moderate.  
Passagem do Tho' on Bahia
- End of Sheet 24 - now take Sheet 23.
- 283 1/2 About the Channel leaves the P. side and runs gradually over to the B. side (ascending) with various depths - least, 13 P.  
# This occurs at the lower end of an immense island, d'Assumpção  
Cax<sup>a</sup> da Pavella. Does not seem important. VILLA de CABRÓBO
- 283 1/4 " " Pambuco - Current 4.38 M. (21, 14, 16 P. deep)
- 282 1/3 " " VILLA do PAMBU (Suppression) on Bahia Side.
- 282 + Channel is now nearest the P. side
- 281 1/3 Cax<sup>a</sup> de Pedra do Moleque (near middle of the main stream.)
- 281 Cax<sup>a</sup> near middle of main stream (no name)
- 280 9/10 Cax<sup>a</sup> near middle " " " " " "
- 280 1/2 Cax<sup>a</sup> do Caxauhy - lower end of island of Calabouco. Numerous mingy islands here bet<sup>n</sup> the main I. d'Assumpção and Bahia.
- 280 Cax<sup>a</sup> do Maria.
- 279 2/10 Upper end of large island d'Assumpção. The point of a Serrote comes to the river half mile above island.  
The Channel shears off to the Bahia side. a third or less.
- Perhaps we can keep along the river and see the
- 278 2/3 Cax<sup>a</sup> do Desataca (Calcão) near lower end of Ilha do Aracapa.  
From this Cax<sup>a</sup> up the Channel is on the Pernambuco side of island.
- 278 1/3 Cax<sup>a</sup> da Imbuicão - near foot of small I. das Boas.  
The main road is only 3/4 mile from the River. It does not look bad, on map.
- 277 9/10 Cax<sup>a</sup> marked 1/3 or 1/2 mile from main road.
- 277 1/2 - The Channel runs off from the main stream along the oblique head of Ilha do Aracapa to the middle of the river. These islands then spread the whole width of the river to 1 1/4 miles. One the island of S. Miguel has a Chapel on it.
- 277 opp. Cax<sup>a</sup> da Ilha Redonda. M. Th. See Sheet 23 MAP.
- about 266 1/2 There are two Cax<sup>a</sup> shown, opp. I. das Almas about 26 1/2 m. also one marked on Bahia side See Sheet 22 MAP.

League.  
276.

Opp. end of Serra Das Caraiabas no, Do OROCO

Cax<sup>a</sup> do Boiv - near here.

From 1/2 m. above 276 L. Channel turns over among many islands toward the Bahia shore - along which shore it continues for several leagues, with various depths and a min<sup>im</sup> sounding of 8 P. some as deep as 70 P.

275 1/2 Cax<sup>a</sup> do Cantagallo - Malhada dos Cachorros

These numerous small islands are surrounded by 3 considerable ones - "da Cax<sup>a</sup>" near the P. shore I. de Vilva de Santa Maria near Bahia side, and I. Grande between and above the two. SEE SHEET 22.

275+ Cax<sup>a</sup> da Vilva <sup>both on the Bahia side.</sup>

274 Fagundes - Opp. this, the road has shown off 1/2 mile from the river, where it takes off, and crosses the Serrate das Cobras

The cluster of houses on the P. side, Caraiabas, is about 274 1/4 L. opp.

follows the road that turns off from the river about 274 1/2 L. we would only 2 leagues away from the river - coming to it again at 270 L.

If there is a road following the river it is about a league longer than the road. See Map.

reached Boa Vista Oct. 7, 1879

Villa da Boa Vista at 268 3/8 L. This puts Boa Vista

about 130 miles (4 3/8 Leagues) above here, Atalho.

Allowing that I traveled along the road 3 leagues per day, including examinations - it would take me 1 1/2 day - say 2 weeks to reach Boa Vista.

314  
246 1/2  
67 1/2

246 1/2 L. now look up Joazeiro -

Joazeiro Villa do Joazeiro, 22+ Leagues above Boa Vista. in Bahia.

From Boa Vista to Joazeiro - 22 Leagues - I could sail 3 days, on horse back - or perhaps in a boat or barge in the same time - though no road is shown. <sup>Boa Vista above</sup>

239 L. # From Joazeiro up to Cachoeira do Sobradinho, is most of the distance main sailing on the river - or should be, according to the Map. about L. 239 - only 7 1/2 leagues above Joazeiro - say 2 days more, on the river. In all 19 days, and allowing stop 1 day in Boa Vista and 1 day in Joazeiro - 21 days = 3 weeks.

That is, starting <sup>any</sup> on the 9<sup>th</sup> Sept. would be at Sobradinho rapids - with my preliminary notes in my book - by the 1<sup>st</sup> Octob<sup>r</sup>. ready in two or three days to return - or to keep on # up the river, as may seem most advisable. \* This was not the case - We did not leave Atalho till the 15 Sept. and we reached BOA VISTA Oct-8<sup>th</sup>.

Villa do Xiqueyique. on the right bank of the Ypoocira about 1/3 league above its mouth, at the head of the very large Ilha do Meradouro - and about opp. 179 L. or 60 Leagues above Sobradinho Falls =

Xiqueyique is not on the Rio S. Francisco but it is connected with it by a navigable channel for barges and large canoes about a league in length. It has also another outlet by a navigable branch along the Ilha do Meradouro, which joins the S. Francisco about 2 1/2 to 3 leagues below the head of the Island. The land between the Villa do Xiqueyique and the main river is called Ilha do Godotrabo. I presume, therefore that there is another connection between the Ypoocira and the S. Francisco, not shown in the map.

167 1/2 L. VILLA DA BARRA DO RIO GRANDE on left bank of Rio Grande at its mouth. opp. the I<sup>a</sup> do Laranjal.

RIO GRANDE.  $167\frac{1}{2}$  Leagues, is [179- less  $167\frac{1}{2}$ ]  $11\frac{1}{2}$  leagues above Xique-Xique.

126.6 L. Villa do Urubú on the right bank of the right hand channel at the Ilha do Urubú - the main town stands a half mile from the river. It is innum owing to the ground being subject to overflow in front.

110.80 L. Sur Bom Jesus da Lapa - on the right bank of the river, on a sort of arm, or bay - (Capella na Pedra Calcária - Ypoera.) Fazenda, same name on left bank of river - All in Bahia.

87. L. Villa da Carunhanha. on left bank of river - opp. island of same name - nearly one league below the Rio Carunhanha - which forms the boundary between BAHIA and MINAS

Bahia  
Minas There is another town on the right bank, about 2 miles above Carunhanha - nearly opp. the mouth of the tributary - called N.ª S.ª do Rozano da Malhada.

80.4 L. The Rio Verde Grande - enters on the right bank - It forms the boundary between BAHIA and MINAS.

The river above this point is entirely within the Província de Minas.

74 $\frac{1}{4}$  L. N.ª S.ª da Conceição de Morrinhos Pedra Calcária (limestone)

64 L. Jacaré - a village on the left bank - in Minas

56.6 L. Porto do Brejo do Salgaão. [ Villa de Januária stands about a league off on same side - the left bank of the river

53 $\frac{3}{4}$  L. N.ª S.ª da Conceição das Pedras de Maria da Cruz - on the right bank.

24 $\frac{2}{3}$  L. Mouth of Rio Paracatu - in Minas a large tributary - soundings shown 2 leagues up.

5 L. about - Mouth of RIO DAS VELHAS or Junction of the two rivers. a large bar in the Rio das Velhas at its mouth. Above, on the map, the S. Francisco appears the larger - but no soundings are given - except for about a mile above the mouth.

Now are soundings given in the Rio Das Velhas above.

0 Pirapóra - Cachoeira da Pirapóra

The Rio das Velhas is mapped 7 leagues up to Roga do Capt. Hippolyto. See next page.

These memorandums made from Haffeld's maps preparatory to arranging a new programme to suit the circumstances - The Comissão Hydrographica being at present in an awkward situation, and doing scarcely anything yet.

M. Halfed's measurements of the das Velhas and S. Francisco, give

The Flow: - For the Das Velhas, 9.159 Cubic palms per second - 743 Palms wide  
549,540 C.P. " Minute 3.09 Vel. per second

276 For the S. Francisco, 22,493 1,349,520 C.P. per minute 1005 Palms wide  
per Sec. declivity 1.65 inches in 1000 P. 3.14 P. per second Vel.

Below the Junction }  
The whole R. S. Francisco } 31,652 C. palms per second } 99.34 C.P. = 1 C. Moku

[P.S. Mr. Halfed says (page 54) that the river in front of Penedo - 6000 palms = 250,000 cubic palms per second. 3,465 palms per second, 1.482 miles an hour - 24 palms above ordinary level in 1833 - and 32 palms in 1792.]

Mr. Halfed estimated cut Pirapora to Sobradinho - \$36:354%  
and m leguas 26 30 39 44 49 52 56 61 67 68  
69 77 78 79 80 81 96 97 107 108 114 122 123  
124 126 136 137 142 142 144 152 159 186 192 196 205  
Marginal work  
Sobradinho to Joazeiro 416:320  
to Boa Vista 53:850  
470:170  
10:400%  
24:000%  
70:754%  
4579  
9159  
18318  
4579  
22897  
470:170  
540:924\$000

His total estimate including <sup>or water front with them</sup> levees to - 1,970:000\$000

Continuation of Letter Eng<sup>r</sup> on Chape  
Reparado von Krieger - dated at St. Paulo  
Sept 5, 1879 - from page 78,

one not favorable for Cahid Handel.  
I will probably send a copy of book -  
animals to show the reason and take  
out the things we need to have with us,  
Circumstances will compel me to  
change my programme somewhat, but  
I may not be able to arrange it later -  
factory before tomorrow.

I will write again when my pro-  
gramme is made up. Meanwhile  
thank you for your attention and  
leave open the door to repayment etc  
W. W. R.  
Grogon chief.

COPY

Memo Ser<sup>o</sup>  
Hand<sup>o</sup> do Sr. Alvaro  
Sinhoro. (Paranahy)

I have just ret<sup>o</sup> from an exami-  
nation of the Cachoeira do Vao, and have  
the pleasure to meet Sr. Cacacand<sup>o</sup> here with  
several letters - one from yourself, dated  
Sept. 3<sup>o</sup> mentioning that you expect to re-  
leave for Rio de Janeiro in the 17<sup>o</sup> or 14<sup>o</sup>  
inst.

I will only take advantage of your  
going to ask you to mention to my  
family, when you see them, that I am  
perfectly well, and that I am, having just fin-  
ished a home - back view of 26 leagues.  
If you should hear of my father, please  
to have him to mention that.

Thinking you be very ag<sup>o</sup>  
I remain very respectfully  
W. W. R.  
Sr. W. W. R.  
Sr. W. W. R.

## Continuation of letter to Chief Engr Krueger

than 1 of 400; but I do not like the idea of changing the rate by increasing it, in any case.

Is it true that the ratios were changed, as stated? Would you advise me to let them draw their families and raise their pay?

I would prefer not to make any change.

We have rec<sup>d</sup> two canoes about 50 palms long. We are not likely to get any more or larger; but we have no boards to fix them up.

In case there is much mail for the Com<sup>o</sup>, by the steamer arriving Tuesday, please use your judgment about sending the mail man at once or waiting till the Thursday mail comes.

I remain &c

W. M. R. Engr on Ch

Atalho Sept 7. 1879

My dear son

M<sup>r</sup>. P. Roberts.

x x x. I want you to ascertain (and get an estimate of) the cost of a <sup>small</sup> steamer in Pittsburgh, so that she can be taken apart (now launched) for shipment to the S. F. River - via New Orleans. Steamboat, <sup>about</sup> 100 ft (clear of wheel 20 ft beam - to draw about 2 ft. light; and 3/4 ft loaded with 100 tons; strong enough to tow 2 barges, each carrying 100 tons, against a six mile current. Acc<sup>o</sup> Cabin, my plan; for 50 permo. The price generally, for shipment, to weigh less than 2 tons - extreme case (1 or 2 pieces) 3 tons. To be shipped to N. Orleans, then to be put on board of a vessel (not draw more than 10 or 11 ft.) for the mouth of the S. F. River.

Correspond with M. B. Adams & Co., <sup>Philad</sup> about freight to Mouth of S. F. River.

I do not confine you strictly to the above dimensions.

Consult Capt. R. C. Gay,

do not create the impression that any such thing has

been ordered. I want merely estimates of the cost of the different movements - cost & time of getting the boat up on the Upper S. Francisco & launching her 2 men - to come out; one for the hull &c, one for the engine, etc. Plenty of good help on the ground.

You can let it be understood as a suggestion of yours - to write to me. Suggest as much as you like. The cost after she reaches mouth of river I can estimate here, if I know how long the 2 men, with plenty of help, will take to put her together and launch her on the S. F. river.

Love to Julia and the babies, &c

Your aff. Father, W. M. R.

Sunday Sept. 7<sup>th</sup> Continued!

Finished writing about 9 P. M. and made up mail; directed to Mr. Krueger - which is to start at 2 a. m. tomorrow morning to be in Savannah Tuesday evening.

A very fine day. The wind is not so strong this evening, as usual. Warm, in the Sun; but pleasant in the shade to day.

Monday - Sept. 8<sup>th</sup>. Atalho.

A bright beautiful sunrise a few minutes before 6 o'clock.

Announced that another canoe has arrived; sent down by Sr. Amaranite, who has gone farther up the river after <sup>the</sup> another.

Senhor Amaranite returned to day having purchased in all 5 canoes; 2 averaging 50 palms (35 ft.) <sup>av.</sup> 38 palms (27 ft.) and 1 of 30 palms = 21 ft.

A heavy barge, about 4 ft wide & 50 ft long also came from above laden with hides and sugar, in cakes.

96. Monday Sept. 8, Continued.

This barge is said to have cost 300% over when new. It is no longer new. It is very heavy, and lugg, and leaks badly. I doubt whether it would suit our work on this part of the river. I will first see what we make in the way of "ajoujou" out of our Canoes.

We had to send 4 liaques to the woods to get timber for our oars and masts. The oars are made, well made by six two Carpenters. They are excellent workmen.

I now think of sending about half your cargo, or some 90 arrobas of it on pack animals to Cabrobo, to light our boats, unless this barge that is here will agree to take it off in time for us at a lower rate.

The usual charge from here is 8,000 per pack animal; or 18,333 per arroba. 6 arrobas per animal. a trifle over 2 cents per pound, for say 80 miles, by the road. [about 93 miles by river.]

Our instruments, sails, tables, etc. came this morning on the pack animals I had sent after them. They report that the Liaque with boards will reach Jaboa tomorrow morning or the next morning.

I re-perused with interest the admirable paper of Thomaz Garcez Paranhos Montenegro - 1875  
A. Provincia e Navegação do Rio São Francisco.

- leaque
- 294 Going up stream - varzea Redonda
- 310 Rapid of Itacutiara - Cancella. I have been there
- 299 Cachoeira do Vão! Espinhos! } This is all on series from 299L to 296 1/2
- 297 Jura - Olho - <sup>Rapids</sup> Linha Island - Tacurubui } 2 1/2
- 297+ Urubri - Rapids.
- 296+ do Costume Villa of Rodellas! Bahia - Munão de São João Bays, de Rodella
- 296 Boni Velho - Rapids.
- 295 1 Passagem - Island.
- Panella, de Baxio, Whirlpool, Called dangerous!
- 293 Caxauhy de Cima - Rapids.
- 292 3/4 Cax - de Cantagalla - Rapids
- 292 Rozario - Rapids - Extensive.
- 291 1/2 Umbuzeiro - Rapids -
- 290 3/4 - - - Currallinho, Farm, Bahia de S
- 290 X Tubarana Povoado de Abanc - 20 hours. salt market of Tamaril, a little river
- 286 1/2 Quebra - Canoa - Rapids
- Cachauhy do Meio - Rapids
- 286+ Estreito Low pt. I. d ASSUMPCAO 160', left side.
- 283 1/2 CABROBO. on Left side

Cabrobo is nearly half a leaque from the main channel, which is on the Bahia side.



98 Counting up stream.

- 283½ Banco d'Arã - Rapids.  
 283 Favela - Rapids. 2 channels - least cur. on the one on left side.  
 282½ Pambusinho - Rapids - Extensive - great Cur.<sup>t</sup>  
 282 Pambú - Rapids. -  
 282. Pambú - village - Capim Grosse 30 Houses.  
 281½ Molegus - Rapids.

Indian Village  
 Chapel - Our Lady of the Assumption

279½ Cachandy de Cima - Rapids  
 upper end of Id. d'Assumpção Large Id.

Portão - Rapids - called very dangerous. pass going down run to Caboto.  
 Island 5 leagues long, Assumpção  
 Better channel Bahia Side.

Mocós - Rapids -  
 Side of Sacco  
 quite Extensive.

278½ Umburanas - Rapids - a little Fall of water, narrow channel bet<sup>n</sup> 2 large rocks.

277½ Faz. do Aracapa (Island) same name.  
 Chapels - ruins  
 S. Miguel on the Rt. S. Felix on the left.

Almas - Rapids.

Machado - Rapids

From league 276 to 277½ complicated

Counting up stream.

Panella de Cima - Rapids ("Panella" a pot.)  
 (The calm water <sup>river</sup> <sup>near</sup> <sup>the</sup> rapids.)  
 Whirlpool in these rapids.  
 near a Rocky Hill on left side.

Inhanhuru - Rapids.  
 River divides in many branches.  
 and the ilhotes (small islands) are <sup>numerous</sup> many.

Gros - left side - a place, so called.  
Estreito - Rapids.

Sacco Torto Rapids

Carapute Island.

Vieira - Rapids.

Fuzib - Rapids.  
 or Fuzio, as the Indians called it.  
Te lippe José Dias Santos  
 Pilot, lived on Id. Carapute

268½. 550 Pop. BOA VISTA. Pernambuco Side on Hill of Rocks.

Reference on 3<sup>d</sup> sheet (of Translation) to Steamer "Saldanha Maranhão" having (in or before 1875,) come down to Boa Vista and back.

Below Boa Vista the river was regarded as unnavigable - except by Canoes.

"Igreja Nova"  
 Built by a lady, Mother of the (then) Superior Commander. Old one on I. Santa Maria 6 leagues below.

Cachão - Rapids.

Sant' Anna.

Counting up Stream -

Sobradinho - Rapids. 5 Kilometers below Sant' Anna.

Cachoeira do Vão to Boa Vista is called 30 Leagues.

Krauss Estimates Cost (30L) 1,425,000

It is considered by Halford practically a Clear run from Pirapora to Sant' Anna, do Sobradinho - 240L = 720 miles.

\* In another place his estimate is put at 63,550,000 Low water - May to Oct. The Rapids Sobradinho are an obstacle to free navigation, but in high water the current is the difficulty - Pilot, and ropes.

Halford went up, and down, in his large boat "Princesa do Rio"

Halford's Est	390,000,000
3 different plans.	420,000,000
	670,000,000

Krauss - Est. Sobradinho 35,000,000 to Boa Vista 29,500,000.

Sob

Halford would not estimate cost from Boa Vista to Cachoeira do Vão = 30 Leagues, which Krauss estimates 1,425,000,000. Making a navigation in low water for boats drawing 25 inches. (3 palms).

Krauss Est based on depth of 1 meter for boats of 30 inches below Boa Vista - 25 2 inches draft. P. S. There is such a navigation now, in the lower stage - except the 20 below

No 25 - near Tacuribe - Wed. Sept. 5. I went to the point to which I walked ~~to~~ a natural rock dam into runs across the arm of the river Pernambuco side on a course S. 40 E., the dam bends a little oblique down stream from the shore. Has a fall of 18 inches in 100 feet. 40 ft. from the shore is a drift channel 30 ft wide and deep (more than 1 1/2 meters) - 30 or 40 men could pull the launch through. With the water as at present the night then run over to the main channel on the Bahia side, but with 1 foot less water, the could not pass up here. A dam of rip rap or crib & stone, averaging 4 X 8 - 300 ft long, will narrow the water at this stage (a considerable bottom) to the other side of the island which heads off. This (small island) Another island S. Antonio - up head 200 or 300 meters above - and another S. Miguel, 150 meters further up. There are 3 little bits of islands - 200 to 500 feet above the natural dam. The chute through the dam in the present stage within 2 to 2 1/2 palms of lowest water, is good for canoes ascending and descending. There is another rock ledge from the base of this island across to S. S. Antonio - where a rip rap or crib 400 ft. long would stop a similar volume of water and then turn it all over to the other side of S. Antonio.

Afterward, the same day on leaving the lower end of this arm or branch on the Pernambuco side - I found that the difficulty could not be passed up here in low water.

General course of river N. W. 1 S. E.

# This belongs to date of Sept. 5 - 1879

To Comendador Sr. D. Luiz Plinio d'Almeida

Since making my personal examination of the most difficult series of rapids on the river above, namely, the Cachoeira do Vão and others, covering a league in length at that place; noting the general characteristics of the stream for a distance of a hundred kilometers; measuring the volume of its low water flow here; and after studying the reports and maps of Engineer Halpelt, and Krauss, as well as the graphic descriptions of Captain Burtin and the excellent paper of Senhor Thomas Garcez Rodrigues Montenegro, (published in 1865), I conceive that from my long familiarity with the phenomena of large rivers, I can, <sup>now</sup> intelligently judge respecting the kind and extent of the additional information needed, and also of the best way to obtain it, in the shortest time.

I deem it a pleasing duty, in behalf of an absent gentleman, whom I never had the honor to know, Civil Engineer Halpelt, who traversed this river in 1852-53 and 54, and whose report and maps were kindly placed in my hands in the City of New York by his Excellency Sr. Borges, the Brazilian Minister to the United States, to say, that they contain a large amount of valuable information, which must have been of great advantage to succeeding explorers, and which I am now sure will be of my great service to this Commission, saving much time, and enabling us to comprehend the main features of the stream more readily, and much sooner, and at less cost, than would have been possible without these important aids.

I make this statement now, because it had been intimated, by different persons, that the data exhibited on Engineer Halpelt's maps were largely fanciful. On the contrary, so far as <sup>have</sup> the opportunity of testing them, between the Ocean and Piranha, and on a

\* I do not refer to Astronomical Observations, but to their relation to the practical river work.

hundred kilometers above, the Falls of Paulo Afonso, they appear to be substantially correct; quite sufficiently so to aid us essentially in our present season's duty. \* True, Mr. Halpelt's maps and report do not contain all the details needed by the engineers in forming exact final plans; nor, <sup>will</sup> can this Commission have time in this preliminary examination to acquire them. Nor are they necessary, until the general plan of improvement is determined. I now believe that, with the aid of the surveys and reports of Engineer Halpelt, and Engineer Krauss, the latter of whom surveyed the most difficult portion of the river between Sobradinho and Jatofo, the Commission may be able to examine all the important points, to the upper end of the Sobradinho, during the short period remaining of the low water season. <sup>Engineer Krauss's survey, covering the most difficult portion, gives more details</sup>

All of the observers who have passed along the Upper San Francisco concur in stating that the serious difficulties lie between the lower end of the Cachoeira do Vão (239<sup>1/2</sup> league) and the upper end of Sobradinho rapids (299<sup>1/2</sup> league) covering 60 leagues; and that from Sobradinho up, for 239 leagues, to Piraporca, the river is already a fair steamboat navigation, needing only comparatively trifling work by the removal of a few partial obstructions to perfect it.

Hence, if the Commission succeeds in accomplishing the necessary low water examination before the Annual rise reaches Sobradinho, the main object will have been secured during this one season. Unless the Annual rise should be unusually early we may get considerably farther up. It is important that I should see the upper part of the valley, or as much of it as possible, this year.

Next, in importance, to the study of the stream in its low stage is the observation of it in a medium or ordinary <sup>half</sup> flood height say in November and perhaps part of December. This I hope to do on my return. Circumstances have already caused us to modify our original program; and they do so again.

Our measurement of the low water flow of the river, at Atalho, made Sept. 5<sup>th</sup> 1879, after reduction to the assumed level of extreme low water, gives 60,780 cubic metres, or 2,150,396 cubic feet per minute.

This will fill a channel 271 feet wide, 20 feet deep, having a velocity of  $4\frac{1}{2}$  miles an hour. This is very large for the low water flow, and ordinarily, excepting in September and October, it is much more on this part of the river.

In 1852, Mr Halford measured the low water flow of the San Francisco at the junction of the Rio das Velhas, including both streams, and found it to be 19,140 cubic metres, or 677,173 cubic feet per minute.

That is, a little over one third of the quantity found here, <sup>314 leagues, or</sup> 942 miles below his point of measurement.

Even there, at the upper end of these 942 miles, the quantity flowing will fill a channel 181 feet wide, 10 feet deep, having a velocity of  $4\frac{1}{2}$  miles an hour.

These dimensions are given merely to convey a practical idea of the volume of the flow.

From the measurements, it is clear that there is, at all times, an abundance of water, and during more than three fourths of the year a superabundance for an excellent steamboat navigation if it be advantageously directed into proper channels. <sup>(The same as here, less the warbolem between Atalho and the falls.)</sup>

According to the above, two thirds of the present low water flow passing over the Paulo Affonso Falls, comes from the tributaries below the Rio das Velhas; and as none whatever enters at this time from the lower tributaries, it is furnished by the upper streams, <sup>which</sup> entirely below the Rio das Velhas.

The upper tributaries are therefore radically different from those below, in a

most important particular; <sup>for</sup> While the lower tributaries are dry most of the time, and never furnish any supply when the river needs it, the upper tributaries never cease to flow, <sup>so that</sup> they are all the time adding to the quantity in the main stream.

Of course this difference in the vital characteristics of the upper and lower tributaries, involves a radical difference in the <sup>metamorphosis and other</sup> characteristics of their respective valleys, which must materially affect their relative productive values. This is here <sup>glorified</sup> ~~shown~~.

The large quantity of water in the Upper San Francisco in its low stage, has a very important bearing upon its proposed improvement, the engineer not being confined by a narrow limit of supply. In most of the rivers along the <sup>east of the Rocky Mountains</sup> Atlantic slope in the United States, the Ohio, for example, the extreme low water flow becomes very small. <sup>Pittsburgh</sup> at the junction of the Allegheny and Monongahela rivers, at Pittsburgh, Pennsylvania, is 967 miles above its mouth. The San Francisco at the junction with the Rio das Velhas, is <sup>942</sup> miles above the Falls of Paulo Affonso. They have nearly the same length between the points mentioned. <sup>upper</sup>

But the low water flow in the San Francisco at the Rio das Velhas junction, is six times greater than the low water flow of the Ohio at Pittsburgh.

On the Monongahela river, one of the two great <sup>tributaries</sup> which form the Ohio, the low water flow was found to be so small that I recommended, and also constructed, a regular system of locks and dams <sup>upstream</sup> (in 1839), which, has ever since been in successful use; and at this time the government of the United States is constructing an experimental lock and dam on the Ohio just below Pittsburgh.

If the low water flow on the <sup>Upper</sup> Ohio <sup>had been as great</sup> as it is on the Upper San Francisco, I would not have proposed locks and dams for the Ohio river,

106 because that only, than indicated a fair navigation  
 for the year without such artificial aid of water.  
 Locks are not necessary on the Upper San  
 Francisco below the junction of the Rio das  
 Velhas down to Jaboa, the terminus of the  
 Paulo Afonso Railway, as there is <sup>enough</sup> sufficient  
 water always in the river to make a naviga-  
 tion for steamboats, when harnic into proper channels.

I have not yet made a study of the  
 reports of the San Francisco and the Rio das  
 Velhas about their junction, so that I am not  
 yet prepared to form an opinion respecting their  
 capabilities in connection with navigation.  
 According to Mr Halford's measurements, the  
 volume of the Rio das Velhas was <sup>5545</sup> ~~5545~~ <sup>Cu. Metres</sup>,  
 or 196,182 Cubic feet per minute, while that of  
 the San Francisco, (above the junction) was  
 13,595 Cubic metres or 480,991 Cubic feet, <sup>being</sup> ~~being~~ <sup>any</sup>  
 2 1/2 times greater, at that stage of the water.

The navigation of the Upper San Francisco,  
 between Piropora and Jaboa, can be improved  
 so as to secure channels through the rapids  
 through which steamboats properly constructed  
 to stem strong currents, can pass, up and  
 down. What the cost will be, I do not yet  
 know.

The cost of improving the rapids will  
 depend considerably upon the depth and width  
 that may be determined upon for the im-  
 proved channels <sup>on the low water period</sup>. No satisfactory  
 opinion can be formed <sup>with</sup> respecting this point till  
 after an examination of the principal rapids  
 between the Cachoeira do Vao and the Sobradinho.

To arrive at the most judicious dimen-  
 sions (depth and width) of the improved chan-  
 nels, some reference may be advisable not only  
 to the present but to the future commerce of the  
 Valley, and of its contributory valleys.

It is, however, obvious, that upon four-fifths  
 of the length there is now a good steamboat  
 navigation, needing only the removal of a

few obstructions which interfere with it, and  
 which when removed will leave a clear chan-  
 nel of sufficient width and depth to accommo-  
 date a large Commerce.

Between the rapids, (although in places  
 the current is strong, running at the rate of two to  
 four miles an hour; at some points even more <sup>than four</sup>,  
 may often much less than two miles an hour),  
 the channel depths and widths are <sup>now</sup> ample for  
 any steamboat navigation that could be possibly  
 considered necessary.

It is usual, among engineers, to reserve a  
 notice like the foregoing, to be presented only in  
 the official report, to be made after the conclusion  
 of the season's work; but it is to me more satisfactory,  
 and it has been my custom for some years past, to  
 offer, <sup>now</sup> formally, ~~the~~ facts and resulting views  
 as soon as they are acquired, to the parties  
 interested in knowing them. Of course it  
 is always possible that further examination  
 and study may lead to their modification  
 or their <sup>facts and</sup>.

I do not hesitate to say <sup>to you</sup> that  
 the improvement of the Upper San  
 Francisco appears to me to be more feasible  
 than I had anticipated before seeing it;  
 and this judgment is based chiefly upon my  
 preliminary examination of the Cachoeira do  
 Vao, which is pronounced by both of the Engin-  
 eers, Halford, and Krauss, to be the most  
 formidable of any on the river, above here.

Above Sobradinho, the facts to be gath-  
 ered, respecting the agricultural and min-  
 eral resources, now lying dormant, may be  
 even of more consequence than the determination  
 of that part of the river <sup>which</sup> ~~itself~~ <sup>according to the facts</sup> seems to need  
 so little to render it a fine navigation; which  
 in fact seems to be already a fine navigation, <sup>to be</sup>  
 W.M.R.

\* a channel across water will narrow the river, and it is very difficult to find a channel which will carry a large volume of water.

108 Tuesday, Sept 9, Atalho.

a warm day. Spent most of it writing a very long "unofficial" letter to Comendador, Sr. D. Luiz Plinio d' Oliveira - see C preceding pages for a (nearly) verbatim copy, or original, rather.

I also began an Officio to Sr. Amarante, 1<sup>o</sup> Eng<sup>o</sup>, modifying my letter of instructions dated Aug<sup>o</sup>, but not being satisfied with the shape of it, I adjourned till tomorrow.

We have been in negotiation with the owner of the barge who is to take about 80 arrobas of our stuff up to Cabotá. 31 leagues by river, at 6 \$000 per cargo - or 1 \$000 per arroba and we are arranging the division, so as to take about the same quantity in our ajoujou - when we get them fixed.

We will have first rate oar and masts; but they have sent us very flimsy sails.

Also arranged to send one canoe after boards to Jatobá, hoping they may be there to night or tomorrow morning.

I am also arranging to make a small land party to go as far as Cabotá - myself, 1 Engineer, Mr. Derby, 1 Cook, 1 gulard, and 1 man to attend 3 pack animals. 6 persons and 9 animals.

Sept. 10<sup>th</sup> at Atalho 2500 \$ to Sr. Amarante  
1600 " in white bark  
100 " in value

109 Wednesday Sept. 10. Atalho.

Engaged most of the day writing and copying letter modifying instructions of Aug<sup>o</sup>, 1879.

See pages 111 to 116 inclusive - for copy.

Heard that we had to pay 2 \$000 per cargo for Capem - when we had understood it to be only 1 \$000.

We are now getting 8 miles off at a cost of 1 \$100 - in getting and transporting it; but that costs nothing as the men & their tools & provisions are all.

Our canoe, which left this morning at 6 o'clock for Jatobá came back at 4<sup>1/2</sup> this evening, with 40 boards (out of the 72) which I now think will be enough for our canoes. The boards are Cedar of the country - some lighter than pine about 9 1/2 in long by 9 1/2 in, 9 to 9 1/2 in thick with 1 1/8 to 1 3/8 in thick. These 40 boards weigh say 1000 lbs - with 3 men say 500 lbs = 1500 sank the canoe about 7 inches - leaving about 8 inches out of water.

The two carpenters are hard at work trimming down the large heaviest canoe - they have reduced its dimensions considerably.

Uted, Sept. 10, Cont.

This morning, in presence of Sr. Sabria, I handed to Sr. Amarante two packages of money, Brazilian Government notes.

One Containing	1500\$
on a	1000\$
	<u>2500\$</u>

This is part of the 4057\$ I rec<sup>d</sup> from Chief José Kruger in Pirantós. The 1557\$ I have, and I am accountable for only 1557\$.

Sr. Amarante is accountable for the above 2500\$000

*See page 109 for description of the shape of the channels. The primary channel is at the rapids.*

See page 117 for Sept. 10<sup>th</sup> Journal.

"Camminas Hydraulica"

3<sup>rd</sup> Mo. Sen<sup>a</sup>

Atalho, Sept. 10, 1879

D. Ant. P. Peixoto Amarante  
Primeira Engenharia  
Atalho.

Owing to the limited accommodation in the Canoes, and the manner in which they will be worked up the river, it is necessary to modify my instructions dated Aug<sup>t</sup>: 1879.

Only such of them as can be conveniently attached to rafts be carried out.

The daily map, on double <sup>or Hassfeld's</sup> scale, may be dispensed with. Instead thereof, sketch maps, only at the rapids, need be made, showing, on double of Hassfeld's scale, the Channels, islands, rocks, swift-water, and falls; and as nearly as it can be ascertained approximately, the rate of the swift currents.

On other portions of the river, Hassfeld's maps is to be used as a basis; and new information, and corrections, where necessary, are to be marked on the maps, in pencil.

Regular soundings are not now expected, as the Canoes are not likely to be made in the Channels. Soundings, when taken should be recorded, especially any below two metres; but in such cases a note should be made, stating whether there is deeper water in the Channel.

Only one cross section need be taken below Cabot's as any convenient place that may be selected.

Our observations will be mainly directed to the rapids, where if necessary the Canoes can be detained. On other parts of the river they should advance as rapidly as they can.

The principal point, at a rapid, is the position of the Channel (or Channels, if more than one) its shape, and character, the rates of the strong currents, and, (roughly) the proportion of the whole river flow in it, when it

is only a part.

Generally, where a rapid is not complicated or very difficult the main features can be ascertained and noted without stopping the Canoes for the purpose.

At difficult or bad rapids, time may be taken to get clear sketches. Accuracy is not expected, nor is it necessary, in the present preliminary examination, but it is desirable to show clearly what the chief difficulties are, and about the widths and depths of the low water channels, as they exist, and the position, extent, and nature of obstruction.

At the Cachocera do Vão, and the other rapids, Coruchá, up as far as Rodellas, fact or five days may be required to get the needed information.

A level should be run, so as to get the fall and distance (to be taken) from the lower end of the lower rapid, on the Pernambuco side of the Serobabi island, to a point just above Jacuriba rapids, (about one league or leveling) Notes of the positions, etc., of the different rapids in that branch of the river should be taken by them men do the leveling. The Transit line can be run at the same time from the same stakes, and courses taken that will assist in connecting the sketches and maps. If lines can be found near the beginning and ending Benchmarks should be made and marked.

# From the examinations I made, my present impression is that the Steamboat Channel can be made at less cost, and with an easier descent, on the branch along the Pernambuco river. If not all the way from the head of Quite island, or at least from where the Canoe Channel now comes

over to the Pernambuco side from the main river. A cheap dam, of loose rip rap, of large stones, thrown out obliquely at the head of Quite island, can be made to guide into that Channel the additional water needed - provided other things favor that side for the Steamboat Channel.

I have no doubt that a low water Steamboat navigation can be made through the main Channel, where in low water, there are two considerable falls; but it will probably be more costly, and have a much swifter current than the other, on account of its short length.

It will be necessary to run the level along the Bahia side, also, to ascertain the position of the river forming these two falls - say from a point four or five hundred feet below the lower one to a point four or five hundred feet above the upper one; rising, with the level, the heights of each fall from a point about 20 meters below to the same distance above each fall.

If there are other falls above, you can judge whether they should be levelled around or not. Where there is no actual fall, and the current does not exceed about 5 miles an hour, no leveling need be done (except that part above designated along the Pernambuco side at this particular locality). Four or at most five days will be time enough to get all the main features, at this place.

According to Halsford's soundings, there is depth enough <sup>in the Lagoa Channel</sup> from the main stream over to a point opposite the head of the Island of S. Miguel along the present Canoe Channel. If the Steamboat Channel be made in that direction, it will probably be advisable to build a low rip rap <sup>dam</sup> - dam across to the Island of Jacuriba, in order to hold the water to the Pernambuco Channel, and also,



below that, to close the small channels between S. Miguel and S. Antonio islands, so as to carry all the water brought in from above over to the one Pernambuco Channel.

Observe as much as you can respecting these points.

The rough stone dams referred to, have only to be about as high as, or very little above the present surface of the water to divert it. In some cases "Cuts", built of rough timber, and filled with rough stone, may be employed.

I have already seen enough to comprehend the general Character of the Obstacles in the way of a good steamboat navigation on this river.

Where rocks occur in any channel intended to be improved they must be removed. These should all be noted.

The longer a channel can be made through any series of rapids, the better; as the declivity on a given distance is lessened correspondingly; but if a good tolerable straight channel can be obtained without having too much velocity, it may be preferable. Experience, and judgment, can settle such questions when they arise. Velocities over 4 or 4½ miles an hour, are objectionable — they are not to be encouraged; though proper steamers can overcome them.

The works required to make a steamboat navigation on this river are chiefly at the rapids; and in <sup>kind of</sup> they are few, and simple.

1. The removal of obstructing rocks.

2. Closing Cutaway island channels, with single stone dams (rap-rap) or, in some cases, with cuts filled with stone; in order to divert the flow of water into some desired channel, and to prevent the water from being lost from the Channel.

3. Dredging, however, is required, in order to ascertain which is the best route to be selected for the improved or Steamboat Channel.

The Cause of the simplicity of the works required, is the very abundant supply of flowing water in the river, at its lowest stage.

If this quantity had been limited to a small amount, as it is in many rivers, the Cost of its improvement into a good steamboat navigation would have been much greater, and the works more complicated. In fact, if this river had no greater flow in its low stage, than the Ohio river (in the United States) in its low stage, it would not admit of a steamboat navigation during low water, excepting by means of locks and dams; the Cost of which, in this valley, would have been enormous.

After deducting one fifth from our measurement of the 5<sup>th</sup> of Sept. to allow for the lowest depression in the stream at this place, it still leaves 60,816 Cubic metres per minute or 2,146,800 C. feet.

Engineer Hulsfeld in 1852, states the low water flow just below the junction of the Rio das Velhas (314 leagues above here) to be 19,140 Cubic metres, or 677,173 Cubic feet.

This is six times the low water flow at the head of the head of the Ohio river, at Pittsburgh, Pennsylvania.

Now, a Channel 20 metres wide, 2 metres deep, flowing 2 metres per second, (or about  $4\frac{1}{2}$  miles per hour) would require only 4800 Cubic metres, or 169, 824 Cubic feet per minute. And yet that would be a good steamboat navigation, in a tolerably fair Channel, free from abrupt bends!

Thus the water flowing past Atalho to day, would be insufficient to fill 12 such Channels; and even the quantity at the junction of the Rio das Velhas, in low water, would fill about 4 such Channels.

During three fourths of the year the flow is much greater.

There need be no question, then, as to the practicability of having a steamboat navigation on the Upper San Francisco, without locks. What we have to ascertain is, the best mode of getting a fair Channel, at the least cost.

Wherever we find, already, through any rapids a Channel as wide as 20 metres, 2 metres deep, the velocity of which does not exceed 5 miles an hour, it may be safely called a fair steamboat navigation - if free from abrupt turns. If, however, our observations show that for a small outlay it can be made safer, or better, that fact must be specially noted.

After the Commission has fully started upon its work on the river, I propose to proceed in advance, to examine some points farther up, and I will communicate with you from time to time. I shall the honor to remain very resp<sup>t</sup>. W. Milner Roberts  
Eng<sup>r</sup> en Chef

Atalho Sept 11. 1879 (117)

D<sup>r</sup>. Reinaldo Von Krüger - Eng<sup>r</sup> en Chef to  
I learn that a man is to start in a few minutes for Piranhas, and having one letter ready, I enclose it herewith - please mail it

We sent a Canoe to Jaboti yesterday, which brought in 40 out of the 72 boards. We will probably not need any more. If there are any left unused, I will leave them in Camp Senhor José Manuel de Souza.

We are busy getting the Canoes fixed. Their capacity being limited, we are obliged to send half of our Cargo by another Convoiance to Cabrobó. We expect to leave here within two or three days.

I thank the honor to remain  
my resp<sup>t</sup> yours  
W. Milner Roberts  
Eng<sup>r</sup> en Chef

P.S. We hope to receive  
mail from Piranhas  
before we leave.

Rec<sup>d</sup>. This memorial from  
Sr. Amarante 60\$000  
if it be the sum I let Rudolph  
the Steam Engine have  
at Pernambuco.

60\$000!

that is new  
The owner of the barge, here - sends word that he is ready to load to day, and start tomorrow for Cabrobó. He is to take up Cargo (31 leagues) for 1\$000 per arroba - We suppose about 50 arrobas can be sent that way.

Sr. Amarante Mr. Derby and I  
We tested the largest Canoe to day with gutta serena of a tenting man, Capt. Piranhas. It worked very well.

118/ Commisario Hydraulica  
 Alalho Sept. 12 1879.  
 Ill<sup>mo</sup> Senhor  
 Tenente Coronel Francisco dos Santos,  
 Sr. Soares de Alvello Avellano  
 Cabrobo.

Manoel José de Brito. to transport I have engaged the Sr.  
 to transport from Alalho to Cabrobo,  
 part of our provisions and other articles,  
 amounting to about 115 arrobas  
 which he has agreed to deliver to you  
 in good condition within ~~the~~ <sup>days</sup> ~~of~~ <sup>from</sup>  
~~the date~~, for which you have accepted receipt  
 promised to pay him \$500 upon  
 the delivery of the same as above.  
 Will you be kind enough to receive  
 and take charge of the same, until  
 we arrive at Cabrobo; which will probably  
 will be only a few days after the  
 delivery of the said cargo.  
 By so doing you will greatly  
 oblige your amigo  
 Sr.

Accompanying this is a bill of lading of  
 the cargo.  
 I enclose herewith a letter of introduction from  
 Senhor Cavalcanti.

119  
 Alalho Sept. 11<sup>th</sup> 1879  
 Study of the Profile of  
 Ascending the River -  
 Palmo = 8 1/2 inches

	Palmo	ft.	L.
Sorobabe	1 1030	299 1/2	
Cachoeira do Vão	2 1030	6000	
" do Cruzeira	3 1036.4	3 2/3	298 1/2
" do Espinhos	4 1047.	10.6	298
" do Tacuruba	5 1049.4	2.4	
" dos Cavallos	6 1053.4	4.	
" Fura Olhos	7 1054.4	1.4	
" de Rodellas	8 1056.	1.6	
Miss <sup>a</sup> de S.B. de "	9 1057.3	2.3	297
Cachoeira do Cortum	10 1061.5	4.2	
Jatinan de Barrio	11 1064.6	3.1	
Cach <sup>a</sup> do Bor Velho	12 1071.2	6.6	
Faz <sup>a</sup> da Canabrinha	13 1073.6	2.4	296
Jatinan de Cima			
Passagem.	14 1076.6	3.00	295
Cach <sup>a</sup> da Panella do Dourado	15 1090.	13.4	
Araticum e Serrote <sup>de Barro</sup>	16 1092.3	2.3	
* Arnipo	17 1097.5	5.2	294
Cach <sup>a</sup> do Cambagaba	18 1113.3	15.7	293
Rosario	19 1123	4.7	292
Curratinho	20 1128	13.	291
Cach <sup>a</sup> das Flores	21 1142.6	2.6	290
" Quixaba	22 1153.4	3.8	289
" Panatá	23 1157.	3.6	288 1/2
" Zapague e Mucó	24 1163	6.	288
Barro do Negro e Mucó	25 1174	11.	287
Bor Vis. e P <sup>a</sup> da Assumpção	26 1186	12.	286
Cach <sup>a</sup> do Pambuzinho V. a Cabrobo	27 1195.2	2.6	285 1/2
	28 1200.2	5.	285
	29 1205.2	5.	283 1/2

V. de Cabrobo

1752

\* Roundly - say } 1165.5  
 In 48 miles 149 feet } In 6 miles - Rodellas  
 or 3.15 per mile - } to Sorobabe - Falls  
 18.7 ft = 34 ft per  
 mile -

\* In 15 miles (from 294 to 299 L.)  
 the fall shown is 51 ft  
 3.4 ft per mile -

See page

(from table) the  
 mathematical formula -  $\sqrt{\text{from depth and declivity}}$  would give a  
 greater velocity than exists. A very important, and valuable element  
 in these rapids is the rough, ragged shape of the rocky bottom and  
 sides of the channels, which retard the natural flow by the friction,  
 but still may be the vertical and lateral counter currents and eddies  
 which check the onward motion of the water.

Continuation of Study of the Rapids from Sobrobabe to Cadroba. 16+ Leagues = say 48 miles = Fall say 149 = 3.15 ft. per mile.

### Remarks.

Order an Stern-wheel steamboat of light draught on the upper Allegheny River (the larger Confluent which forms the Ohio river at Pittsburgh, forty years ago ascended the stream when the fall was 4 feet per mile; the water flowing over a gravelly bottom.

The stream being comparatively shallow, the velocity of the water was considerably retarded by its passage over the gravelly bottom and sloping sides of the channel. The precise measure of the retardation from this cause was not ascertained. It would vary materially with varying depths of water.

The actual amount of friction would increase with an increase of the depth of water, from five causes; namely, the greater wetted <sup>perimeter</sup>, and the augmented velocity, due to the effect of gravity; but the proportion of friction, compared with the increased volume of the flow, would be less.

So much depends upon the character of the bottom and sides of channels, and the quantity of water passing through them, that it is not merely difficult, but it is impossible to use any formula, without special

Remarks continued.

reference to the particular case to be considered.

A formula <sup>of Galt</sup> made from experiment, <sup>in any size and any shape</sup>, which will apply, under similar circumstances; but these are rarely similar.

The circumstances at the rapids on the Upper San Francisco have the general resemblance of <sup>all the</sup> ~~all~~ rock bottoms and sides, mostly rough and irregular; but having various declivities and different widths and shapes. <sup>But nothing short of</sup> ~~Observations and actual~~ <sup>experiments</sup> at each rapid will give the depth and velocity at a given stage of the water in the river. The size and shape of the channel at each place, in connection with the depth and velocity, will give the character of the channel, and indicate the nature of any improvement needed to make it better, at that particular stage of the river.

At the first view, the natural impression <sup>would be</sup>, that the numerous rocky rapids in the upper San Francisco, possessed no redeeming features; that they are only unmitigated evils; and the sole obstacle to a good steamboat navigation. That if they were smoothed down to one inclined plane from Pirapora to the sea, there would remain a perfect navigation.

Let me examine this point according to Engineer Harpell

Sept 11, Thursday - Atalho  
Remarks Continued

the total fall is 17.11 feet in the distance of 114.3 miles, or at the rate of  $\frac{1}{2}$  foot per mile. <sup>Bottom the same</sup>  
If the stream had a smooth regular declivity of  $\frac{1}{2}$  foot per mile, a given quantity of water would pass from the head waters to the sea in much shorter time than it does now because it would have a greater average velocity. The low water period would occur sooner, and the depth would be less during the low water stage than it is now, (excepting certain falls and rapids) and when low it would not rise as rapidly as the pools as it does now along the present pools.

It is ~~now~~ true that with a river of that inclination, having ~~an~~ abundant supply of water, enough to give a depth of ~~5~~ 5 feet in the low stage (with a smooth bottom and sides) <sup>and</sup> an average velocity of about 3 miles an hour, would be a grand navigation.

But could it be so? This river has an average width of more than 2000 feet for hundreds of miles. Calling it 2000 feet wide, and 5 feet deep flowing at the rate of 3 miles an hour, what is the quantity of water required?

It is 2,640,000 cubic feet per

Sept 11, Thursday - Atalho  
Remarks Continued.

At the present time that is in fact about the quantity now flowing at this point, coming as it does through a thousand miles of bends, irregular rocky channels, and through deep pools where its velocity is greatly checked.

In the case of the imaginary river that quantity of water would not be in the river in this place at this time, as a much larger portion would have passed on to the sea. But again, it is to be considered that the San Francisco river is less generous, differing from most rivers, owing to the magnitude of its low water flow.

The confined channels through the rocky rapids necessitate depth - the <sup>same</sup> bars in the pools, occupying a large portion of the width of the stream, necessitate depth in the channels. These circumstances, therefore, are not unmitigated evils, since they serve to maintain a deeper navigation, and for a longer period.

9 P.M. - Sept. 11<sup>th</sup>

Evaporation  $\frac{1}{8}$  inch in 2 hours - (from a bucket of water - not very accurately taken - from 1 $\frac{1}{2}$  to 3 $\frac{1}{2}$  P.M.)

124] Sept. 12<sup>th</sup> Friday - atalho. Journal.

See page 118, for my letter of this date to Sr. Ten<sup>te</sup> Coronel José Soares de Mello Avellins, at Cabrobo, sending to his care a cargo per the barge owned by Ser. Manoel José de Brito.

I also sent the letter of introduction written by Sr. Caralconte.

I went down to our Canoes several times to day, to assist in planning the manner of changing them to Ajajipi. The Carpentarias are doing it well.

I arranged to dispense with 2 of the "guard" party - leaving 12 in front arranged by Mr. Kruger. I wrote to Mr. Kruger, as follows:

Letter to Mr. Kruger. Sept. 12<sup>th</sup>. "Our Canoes will now soon be strapped into 'ajajipi'. We have sent, by a barge which came down here, two thirds of our cargo to be delivered at Cabrobo to Sr. Ten<sup>te</sup> Coronel José Soares de Mello Avellins, to whom I have a letter from Senhor Caralconte.

Two of the men of the Guard return to day to Piranhas, through there are still twelve, including the foreman, which I understood to be the number you had designated. I am willing to retain that number, but no more; as there is scarcely any thing for them to do. I have allowed the two men to take with them one pistol, and their wages are paid to them here, including 2 days allowed for returning to Piranhas.

We are hoping to get some mail before we leave.

I will write again. I have the honor to remain  
M. Milner Roberts  
in haste

John Bogart Esq. atalho, Province of  
Pernambuco, Brazil.  
My dear friend: Sept. 12, 1879.

Here we are, in excellent health and spirits, about 204 miles from the ocean, encamped on the left bank of the Upper San Francisco river, and about 6 hours up stream, on board of "ajajipi" made by coupling by "twining" two Canoes into one double-banded boat. (I have the honor to submit to the Society, as now, "not founda in publicis publicum", the word "twining" - as "above substantially set forth")

On our way from Piranhas, the town at the head of good navigation on the Lower San Francisco - miles from the sea, (and where the river is about feet above ocean level), we rode over the line of the Paulo Affonso Railway, now under government construction. It is 72 miles long; its max. grade, in one place, is getting up from the Lower river valley to the general plain of the Country, is 3 per cent, its minimum radius of curvature 260 ft. - generally, much larger radii - gauge 1 meter. There are about two thousand laborers engaged upon it, nearly all of them being refugees from the districts of Pernambuco, and Ceará, which have been so terribly afflicted with drought, famine, disease and death, for several years past.

We turned off from the railway route a few leagues to our left to view the Great Falls of Paulo Affonso. We arrived there early one afternoon, encamped, and remained there examining that very interesting region till the next afternoon.

There is only one habitation there, in which dwells a "Portuguese" Indian, who is not ashamed to own that he has only ten children; but as he is young, etc, etc, etc.

Sept. 12. Friday. Atalho  
Sittes to Mr. Bogart.

allow me to submit, also, the word "portuguesed" It means, that the Indian language sap has been driven out of him and that he is now fully impregnated with the Portuguese - a La Hay word process. <sup>Impregnated</sup> He was friend, and a "guide" he wanted to be; but the "Americano" portion of the expedition needed no such article. We all made our examinations each in his own way.

The Falls of Paulo Alfonso were not made for the purpose of comparison with the Falls of Niagara; though they may have been formed about the same time, for any thing known to the contrary, the only record we saw, except that of the rocks and water only goes back to 1859, when as the unartistic <sup>young</sup> Emperor Dom Pedro Segunda visited <sup>the falls</sup>. The chief object of the inscription appears to be to immortalize the fact, that the design of the ~~water~~ thing was by Engenheiro Carlos de Aldey, who in 1869, gave birth to the thing, in the City of Pernambuco.

Leaving out this abortion, Nature has <sup>been</sup> attended to <sup>very</sup> ~~well~~ in this vicinity most faithfully, and a grand work has been produced. If I described it well, as a poet, "with my eye in a fine ferny rolling, I should only make a transcript of Capt. Boston's description published about two years ago. Though verbal descriptions of such objects are of little use to those who have not seen them.

These falls are "rockier" (another word, <sup>plainer</sup> than those of Niagara, they are also narrower, Crookeder, more Cascadier, less profounder in one tumble; but more dash- ing and impetuousier, and picturesquar. At the time of our visit, (August 25+26)

Sept. 12. Friday. Atalho  
Secur to Mr. Bogart. [127]

The river was in its low stage, but not its extreme lowest, by about 18 inches; yet the quantity of water then passing over the falls (as afterwards measured by us in the river some miles above) was enormous - Over 2,500,000 cubic feet per minute.  $2500 \times 40 \times 300$  per min = only 30,000,000 <sup>per min</sup>

I make the extreme low water flow, according to the best data we can get, ~~xxxx~~ 2,146,800 c.f. per minute. In floods the upper San Francisco, averaging about half a mile wide, rises 20, 25 and at times 30 feet; so that in a grand fashion, the rugged, ragged, jagged, scraggy, water-worn, black, polished rocks, which now constitute the prominent feature of the black-crook looking landscape, are all covered with the mad torrent, which I should think would nearly tear one's eyes out to look at. In less than a mile the river falls 260 feet, over a rougher bed than I have before seen. The greatest vertical fall in one place is perhaps about 50 feet, and the stream is divided by a rocky island. Rocks, rocks, nothing but rocks; and water. I cannot take more time to attempt the impossible task of conveying to you an adequate conception of this Brazilian wonder. If there had been no Niagara! - well, there could have been no comparison. But as Niagara exists, some people will compare them. The Emperor's sententious expression is probably as good as can be used. After referring to both, from personal observation, he said "They are different."

The river San Francisco is also different from any river I have studied. As yet I have seen a little less than one hundred miles of the Upper river, above the Falls. I have examined the Cachoeira do Vao, 45 to 50 miles above this place; said to be the most difficult in the thousand miles proposed to

Sept. 12. Friday - Atalho

Letter to Mr. Bogart

be improved, and also several minor rapids, and having with me the excellent <sup>and report</sup> maps of Halpeld, the German Civil Engineer who surveyed this river in 1852, 53 and 54, I can plainly see that the general characteristics of the stream are the same all the way.

Numerous rough rocky rapids, with intervening sloping pools of various velocities. Every portion of the stream above the upper terminus of the railway, can be passed by canoes and small barges.

The portion which is grievously afflicted with rugged, rocky rapids above that <sup>junction</sup> point, at Jatoba, to the upper end of the Sobradinho rapids, covers about 216 miles. Above Sobradinho - for 420 miles there is always a fair <sup>canoe</sup> navigation; only here and there a few <sup>irregular</sup> rapids, or minor obstructions to be removed to make a steam <sup>navigation</sup>. In fact, they have a steamer running on that part of the river.

The great characteristic, and vital advantage of this stream is its abundant supply of water even in its very lowest stages.

At the junction of the das Velhas, 942 miles above here, the low water flow is six times that of the Ohio at Pittsburgh!

Not having yet seen the middle <sup>and upper</sup> portions of the valley, <sup>am not yet prepared to</sup> offer any description.

The lower part of the valley, above the great falls, is peculiar; quite different from our American river valleys, and quite unlike other river valleys in Brazil.

The great annual rise of the river, 20 to 30 ft. overflows the <sup>marginal</sup> river slopes and keeps there a supply of fertile alluvial deposits. These slopes, after the subsidence of the floods, are cultivated

Letter to Mr. Bogart.

all along, on one or the other side and in some places, as in this <sup>straight</sup> reach of the river, on both sides; in a small way, raising vegetables, chiefly melons, sweet potatoes, melons and beans, with a little corn, and capim (grass).

At frequent intervals houses occur, situated on the top of the river bank, above the floods. They are composed of clay and sticks, with doors and windows, but no glass, and tile roofs. These are inhabited, generally each house has at least one man and woman and not less than ten children, the younger ones being, unlike the Chickens, without feathers; and the older ones not having too much clothing, the dry climate being very warm; although thus far we have found the nights cool, and we have not <sup>yet</sup> encountered the pest of Mosquitoes.

The high flats, which in a former age were formed by the river, are now for the most part above the highest floods; and many portions have a good soil; but in no instance have these ever been cultivated. They extend from a half mile or less to a mile or more before the land rises <sup>into</sup> mud, and then, as a rule, <sup>in our 3 or 4 miles</sup> this part of the valley, the slope is very gentle.

The flats are nearly bare of vegetation, the sloping hills have a meagre, scrubby <sup>growth</sup> forest, called sertão, consisting of small, scattered trees and large cactuses, which they become <sup>two</sup> a foot in diameter and 30 ft high. This sertão <sup>covers</sup> a very extensive region, on both sides of the river; the Province of Pernambuco on the left, and Bahia on the right, and fortunately it affords some pasture for cattle and sheep - and horses.

There are houses in the sertão; but they are much like those along the river, and inhabited by the same production people. Although all flesh is grass, yet here there appears to be some



39  
130 Sept 12<sup>th</sup>

Letter to Mr. Bogart

flesh than grass - Cattle, sheep and children, being the product.

Now, while <sup>abundant</sup> water is the characteristic of the river, drought, is the prevailing characteristic of this part of the valley. We cross rivers whose beds are perfectly dry, and a which, owing to the drought, <sup>has</sup> been so for several years. Not a drop <sup>of water</sup> comes in from any tributary for a long distance <sup>of many miles</sup>.

In the little valleys of the <sup>Sloping</sup> <sup>Sertão</sup>, the proprietors of the - the settlements (they are not plantations, neither are they farms, nor farming, as we understand it in <sup>our</sup> <sup>country</sup>.) I doubt whether there is a plough in all this part (at in any part) of the valley. Throw up earth mounds to catch some acres of water when it rains. A rainy season is due and over due, but the rain does not always come. This reservoir gradually evaporates, seeps away meanwhile sustaining cattle and people.

By and by it disappears from the surface of the pond - then they dig, and find water. It sinks gradually lower, and they follow down, digging deeper; but at times all these efforts become useless and they lose their cattle.

They have milk and a need to make cheese, but recently they have had to give the milk to refugees from the suffering regions farther in the interior.

<sup>Must be</sup> different farther up the river, because there the tributaries flow perennially, and the towns are known to be important. The change may be gradual - from the comparatively trifling production here to better production farther up. I hope to see it.

Sept 12<sup>th</sup>

Letter to Mr. Bogart

131

One thing is cheering to the engineers. With the large quantity of water flowing in the river, I am encouraged to hope that a fair steamboat navigation may be secured on the 216 miles referred to, without too great an expenditure of money; but antic I see more, of course this is no more than a hope.

The water is here to for irrigation, of these high flats. The river, down to the great falls, has an average fall of over one foot per mile. Strong turbines blow two thirds of way 24 hours, which could pump up a large quantity of water; which, if raised at the upper end of a tract, could be trained over the residue; for many of the flats are lower a fourth mile back than they are at the river bank.

The sky, and the clouds, and the moon, by day, are as bright and beautiful as those of Italy; but the meteorology is widely and sadly different for this region. By night, the stars and the planets - Venus, setting, and Jupiter rising, are indeed brilliant. We had the moon for some time, with her shining face shedding splendid light over the charming landscape of the river and the opposite shore.

"Si Obitana lends enchantment to the view; for when you go over there, there is the Sertão. The hills over there are deeper than they are on this side, and washed with deeper gullies.

We are all well. 37 of us all told, of which 12 are our armed guard. I wanted to do without them; but having been advised by those who ought to know, to take them, I am not now inclined to take the responsibility of discharging them. Thus far they have behaved pretty well. We ate an ox in four days.

Time rolls on - This letter may not find a mail for several weeks, it cannot get to an American steamer before the one of Oct. 5<sup>th</sup>. It

Sept. 12.  
1872

Letter to Mr. Bogart.

would then be about the end of October before you can get it. In Nov. is our annual election. Unless you hear further telling about the nomination, I will know nothing till after the election. I hope that the present dynasty, excepting of course myself, will be continued, and especially that you will remain as Secretary and Mr. Cross as Treasurer.

Perhaps after this year I may be situated a little differently. Now, my whole time and personal attention are constantly, not merely daily, but hourly, given to the examinations, observations, memorandums, official communications with the government, & others.

An occasional letter, like this one, has to be written by jerks - through various interruptions; but if I shall, throughout, be spared to enjoy similar good health, and my load just the same, I think we may be able to make good report of our season's work notwithstanding the delays which have retarded our operations, thus far.

I will enclose with this a check for \$25, to pay my year's subscription. Exemption might be claimed for a part, on the ground of absence from New York; but I do not wish it so; I prefer to be regarded as retaining merely an out-of-pocket status, retaining my status as a New Yorker in connection with this and two or three other societies. I was told in Rio de Janeiro by a young engineer friend that I was like made a member of the Polytechnic Institute; but being born in a stable does not make a man a horse, and I hope now that will not make me a Brazilian. However, I have always, ever since my first visit in 1858, had a higher opinion of Brazilians than any of my countrymen entertained.

Sept 12.

133 [X412]

Letter to Mr. Bogart.

I am looking for a mail to arrive tomorrow, or Sunday for our two-leg express. I had thought we could glean you here before Sunday, but I now think our regular start will be on Monday.

Please give my kindest regards to Mr. Bogart and all of your family, and to all our friends at 104 E. 20.

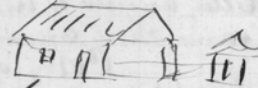
Very sincerely your friend  
P. S. W. Melner Roberts

In the case of your letters - of those which are things in their which in your opinion would be interesting to our fellow members, please use them, at your discretion; through out from Frost, or otherwise.

Also.

Letter to W. M. Larnsdale  
4 pages - Paulo affonso - and  
this part of the valley, with sketch  
of an azojo - and of a house  
and shed + fence

Enclosing Check  
for \$100, (no. 419) to help  
keep my account up



Dated Sept 13, 1872.

134 Sept. 13. Sat. Atalho.

Mail arrived

Two letters came from Adaic, 1 from Col. James, two from Mr. Kruger - one officio from Wilkems Matthe, Director Obras Publicas (and, at once) Rio Xau of 5<sup>th</sup> + 15<sup>th</sup>. Other letters for the party - none for me from the United States.

The officio related to the tax matters committed with payments on the Santos Improvement duty - and Sr. Amarante prepared an answer stating in effect that the tax had been paid, and the list of names given; but that they could not be repeated till we return, as the papers are at Piranhas.

One of Sr. Kruger's [official] letters relates to the arrival of the launch Paulo Affonso - and to the contradiction of the statement that the rations had been reduced, to the families of some of our men who had been engaged for us by Mr. Kruger, as a guard.

The other relates chiefly to Sr. Cavalcante. Letters dated one 10<sup>th</sup> the other 9<sup>th</sup>.

In the evening came a special messenger with a third letter from Mr. Kruger, dated 11<sup>th</sup>, asking me for instructions concerning the launch Paulo Affonso. I had nearly finished my official letter, answered to him of the 10<sup>th</sup>. I now add in the same sheet answer to him of the 11<sup>th</sup>. Atalho Sept 13.

Copy of letter.

W<sup>mo</sup> Sen.

D. Reinadas von Kruger. Eng. en Chef etc.

I have the

honor to acknowledge the rec<sup>d</sup>. of your letter dated Sept 10. in answer to mine of Sept. 5<sup>th</sup>.

I learn from it that the statement made here that you had reduced the rations is false.

I did not believe the statement, but it seemed proper that I should be assured of the truth by yourself.

I do not wish to change the arrangement you made with the twelve men of the Guard.

Sept 13. Sat. Atalho.

135

I am glad to learn that the launch Paulo Affonso has arrived safely at Piranhas, and that the engine is near by, in a canoe; at the same time I have to regret that we could not at present use her here on the upper river.

I have no means of knowing what the wish of the government may be respecting the launch after they learn that the canoe will be here this season on the upper river.

In a letter to the government from Piranhas, I suggested that, in case she could not be used here this season, that she might perhaps be made serviceable between Piranhas and Penedo, etc; but I have had no reply since from the government on the subject.

I should think it would be proper for you to telegraph to Sr. Plinio asking what to do under the circumstances.

In case the launch is not to be used in any service this season, I scarcely know what course is best in regard to Rodolpho, her engineer.

He could be of no use to us now on the upper river. Could you find employment for him in your shop? Perhaps you could set up the engine in the shop and make it do some work.

I expect our arrojios to be ready so that we can leave here and go up the river on Monday the 15<sup>th</sup>. I do not think we will be farther up than Caboto's during this month. #

I had written thus far when your letter dated Sept. 11. came by special messenger.

Sr. Rodolpho was not authorized by me to employ a freeman, at all. I do not know whether any one who has the right authorized him to do so. He is correct in saying that he was engaged at 150\$ per month and his expenses to be paid.

The suggestions I have made above are for your consideration.

In regard to the disposition of the

Launch I do not know that it is to rest upon any determination of mine. I do not know what the views of the government may now be.

I have not been called upon to decide what is to be done with the launch under the existing circumstances.

I have never had any instructions about sending the launch from Piranhas. You were directed by the government to prepare a carriage and take the launch overland to the upper river. I am not authorized to rescind that order. I do not know what the wish of the gov<sup>t</sup> may be when they shall have learned that the launch cannot be used by us in ascending the upper river this season.

If I were in your present situation, I would not take the launch out of the water till after telegraphing and having a clear understanding with the government respecting the best course to adopt.

I feel a delicacy about offering advice to the gov<sup>t</sup> before it is asked for. If my advice were wanted or needed, it would be given to this effect: namely, to leave the launch in the water.

- 2<sup>o</sup> To put the engine into her - provided there is work for her steamer on the lower river - otherwise to leave it out.
  3. To employ the engine on shore, if I could, if not, to put it under cover, and take care of it.
  4. To employ engineer Rodolpho (if I could) in Piranhas; if not, then to pay him off, (to some date) paying his wages, and proper expenses - say to the 1<sup>st</sup> of Nov. including his passage to Rio de Janeiro.
- Dubois Sr. & Com<sup>o</sup> Plénio would take some interest in finding him employment, if I don't know the other particulars of his engagement; but Sr. Plénio does.

5<sup>th</sup> To employ the firmman (or gauger) by Sr. Rodolpho at some other work in Piranhas, (if I could). If he is not willing to remain and be employed, I would ascertain exactly how he came to be employed; and act accordingly.

I decide that you will send to Sr. Plénio in my name, a telegram as follows:

Atalho Sept. 14. 1879.

"Since telegraphing the condition of the river, I have heard nothing in reply.

In the absence of special instructions I advise Sr. Krüger to retain the launch till further orders from the government.

We have constructed two ajoujos. Tomorrow we move up the river, hoping to reach Caboto's this month.

W. Milner Roberts  
Eng<sup>r</sup> on Chefe.

I have the honor to remain to  
W. Milner Roberts  
Eng<sup>r</sup> on Chefe.

Atalho, Sept. 14.

Col. O. C. James  
Rio de Janeiro -  
My dear Col:

answer to his of the -

The evaporation to day from a bucket of water at my tent - from 11 a.m. to 4 p.m. - 5 hours) was  $\frac{3}{4}$  of an inch. Most of the time half the surface of the water was shaded by the rim of the bucket - and at 4 p.m. the entire surface was so shaded, the bucket being only half full.

Letter to Sr. Com.<sup>r</sup> PlinioMrs. Cox<sup>mo</sup> r.h.Atalho Sept. 14<sup>th</sup>

I have the honor to inform your Excellency, that our ajójos are <sup>about</sup> ready, and I have arranged to move up the river to the Cachoeira do Pas, tomorrow the 15<sup>th</sup>. Last evening I received from Chief Engineer Kruger word that the launch Paulo Affonso had arrived at Piranhas, that the Engineer Rodolpho was <sup>also</sup> there, and that he (Rodolpho) had hired a fireman, at Penedo, who was also there. Mr. Kruger wrote to me <sup>with</sup> instructions.

I answer his letter, in effect, that I do not feel authorized to rescind any instructions he may have rec<sup>d</sup> from the Government concerning the launch; but advising him to do nothing with it till he communicates with you by telegraphing, until he has a clear understanding of the wish of the Government after it shall have learned that the launch can be of no use to the Commission this season in ascending the river.

~~His~~ actions, in the case of Rodolpho, the Engineer, whom you engaged, will of course depend upon the decision of the Government respecting the launch.

I have merely suggested to Mr. Kruger about what I would do if I was situated as he is. I then authorize and request him to send, in my name, a telegram to your Excellency, as follows:

"Since telegraphing the condition of the river, I have heard nothing in reply. In the absence of special instructions I advise Sr. Kruger to obtain the launch till further order from the Government.

We have constructed two ajójos. Tomorrow we move up the river, hoping to reach Cabobó this m.m. W. Minor Roberts Eng<sup>r</sup> on Chief

Continuation of letter Sr. Com.<sup>r</sup> Plinio.

After leaving here, our mail facilities will not be so good as they are here; though we have rec<sup>d</sup> my little <sup>mail matter</sup>; although our man on foot express goes through in two days between here and Piranhas.

My plan <sup>when</sup> above here, <sup>at least</sup> for some time, <sup>was to</sup> have a mail sent weekly, from Piranhas, to Jacobá, after the arrival of the weekly steamer (the Sirimbú) at Piranhas; while we send down weekly, to Jacobá, our mail, and receive whatever may be there.

After reaching Cabobó, which is above several difficult places in the river, I will be able to judge better as to our further progress up the river.

I made a trial trip, with our sails, and found that we made much better headway <sup>speed</sup> with the wind, blowing up stream, against the river current, than the <sup>same</sup> ~~same~~ men can make with oars or poles. They have never used sails on this part of the river; but I perceive no reason why they should not be used to advantage, and the <sup>same</sup> ~~same~~ men, and also enable us to <sup>clear</sup> the channels better judgment of the channels.

All of the Commission, and P<sup>r</sup>o<sup>r</sup>. Derby, geologist, continue in good health. Thus far our demands have been much stronger upon the <sup>store</sup> ~~store~~ the medicine chest.

The country, a few leagues away from the river, on the Pernambuco side, is better than it is nearer to the <sup>river</sup> ~~river~~, as at Jacaratú, four and a half leagues from Atalho, where there is water, and some sugar culture.

We hope to find the <sup>country</sup> ~~country~~, generally, improved, <sup>as</sup> ~~as~~ we advance <sup>in the</sup> ~~in the~~ valley.

I have the honor to remain

See page 141 W. Minor Roberts  
for Past Script. Eng<sup>r</sup> on Chief

(140) Sunday Sept. 14. Atalho.  
2<sup>d</sup> letter to Sr. Kruger.

Dear Sir.

Your letter of the 9<sup>th</sup> inst. in answer to mine of the 5<sup>th</sup> inst. was rec<sup>d</sup>. yesterday. Please accept my thanks for your prompt attention in forwarding the telegram which I sent for Sr. Com<sup>o</sup>. Plinio.

I appreciate highly your kindness in tendering to the Commission the services of Senhor Cavalcanti. If he had been permanently acquainted with the valley of the river above here we would have been very glad to have had him with our Company; and if now, in ascending the river it should appear advisable, we will not fail to take advantage of your suggestion, and send for him.

We made a trial trip to day of our larger ajoujos, from here to Jatoba and back. The boat brought up fifteen men, making in all fifty, five and leaving, ~~seventeen~~ seventeen in Jatoba, which we do not at present need. The trial trip proved a perfect success, in the sails.

Although the muslin stuff in the sails is very flimsy, sails prove to be an important help in ascending against the current.

I think that the best arrangement for mail service will now be, to send mail for the Commission, each week, (immediately after the Senhora arrives) to Jatoba. While we <sup>also</sup> send mail each week to Jatoba (in time to reach the steamer of the succeeding week) and receive at Jatoba whatever mail there may be for us.

If you can suggest any more convenient arrangement please do so.

Post script to letter to Sr. Plinio. Sept. 14<sup>th</sup> 141

P. S. Today Sr. Amarantho, Sampaio, Castro & Prof. Derby made an experimental trip with our larger ajoujos, down to Jatoba and back; and found that with a fair breeze they can ascend the Channel of the rapids of the Vargem Rodonda even with a light wind, as it was this afternoon most of the day, they came up in three hours (about 14 kilometers), most of the time sailing against the current.

I have arranged to start up the river from Atalho, tomorrow the 15<sup>th</sup> Sept<sup>r</sup>.

I send the animals across by the short road to Papagaia, (seven leagues from here by river (about 4 by the road)) there to wait for the ajoujos.

We expect the ajoujos to arrive at Papagaia on the evening of the 16<sup>th</sup>.

Monday Sept. 15<sup>th</sup>. We Leave Atalho at noon.

We sent our last mail from Atalho last night - This morning is occupied in loading on 2 Ajoujos and one Canoe - we leave about 10 of our boards in care of José Manuel de Souza - who though ill came down to the river and bade us "bon viaje".

The two Ajoujos and Canoe were pretty well crowded with our things; we bring a number of boards with us in the small Canoe.

At 12. noon, we start, with the large Ajoujo all of the Commission and Proj. Duty on board, with Henrique and Chico, and the two Carpenters and the crew of Indians 4 fine hearty young men and the pilot.

The second Ajoujo and the Canoe, start a little later - 10 minutes or so.

We put up sail, with a very light breeze and with the help of the oars worked our way obliquely across the river, and then the wind dying away or being unfavorable, we were poled up stream for an hour or more, then a little sail help - then poling, still holding to the Bahia side.

[We send 3 Carvers of our things on horses, and nine horses with saddles to Cancellas at the Point of the Papogaia mountain - there to await our coming. They go across the Country on the road which is not over 4 leagues, while our distance around is seven.

At about 5 $\frac{1}{2}$  miles from Atalho, just at the foot of Rocks on the Bahia side - see Map - I insist on our sailing direct for the point of rocks above on the Pernambuco (or right bank) after a little demurring on the part of the Indian Pilot, who is very accustomed to sailing, and wanted to pole up farther, I carried my point - by persistently insisting upon it, as we soon had a nice little breeze which carried us just when we would go - The first point of rocks we came to on the Pernambuco side, was low,

Monday Sept. 15<sup>th</sup>

147

black & jagged - a boy and a man picturesquely fishing off the rocks jutting overhanging rocks not over 15 ft, above the river - a little way above we came to a very prominent rocky projection thrust to the river, a termination of a ridge - which does not reappear on the Bahia side (where it is flat - for several miles - probably all the way over to the river - for there are great bends in the river along here -

A third of a mile above the first prominent projection of Sandstone rock is another somewhat similar - they are all the first one not less and the second more than 100 ft above the water.

There are on the rocks in the river and at its edge, fallen from the main mass large isolated rocks, known as marked with parallel lines of indentation not straight, but like roughly chiseled marks - On the same stone however, I noticed lines that were 60° or 70° from the others in direction.

These marks are new to me. A great many of these marks appear. They are natural - not artificial.

At 5. P.M. - between the two prominent projecting points - about  $2\frac{1}{2}$  leagues - 8 miles or 13 Kilometers in map - for the night - the other boats not being in sight - and they have the Coorsaken and tents on board -

At 5.35. The other two boats sailed up beautifully. I am now satisfied - that exclusive of delays at the rapids we can make seven or eight leagues per day - if the wind favors us half the time. See - L. 311 $\frac{1}{2}$

## CAMP N<sup>o</sup> 3. League 311 $\frac{1}{2}$ . Serrote de Sobradinho

### REPORT. I. (or Sobrado of Halsfeld.)

From Jatoba at League N<sup>o</sup> to this place at (or very near) League N<sup>o</sup>. There is only one rapids of consequence, namely that of Vargem Rodonda about league N<sup>o</sup> 314. Through that rapids there is a good natural channel of sufficient depth, and

146 Tuesday Sept. 16<sup>th</sup> Leave CAMP 3<sup>rd</sup> <sup>after</sup> breakfast

Start at 8:29. Light breeze up river - Current  
of river W. N.W. (above the high rock bet. that & N.W.)

8:38 - Opp. up. pt. of high Rock - 9 meters sounding, but deeper  
in regard to the rock. We sail with moderate wind -  
3 legged ANNA seems to beat us this morning.

Above the big rock are other clumps of partly disintegrated  
red sandstone rock. These are the mountains shown looking  
inwards on Hatfield's map.

Along shore, on both sides is the usual river slope cutting  
8:48 - On a sand and gravel bar in the middle river  
just opening as we sail pole.

9:57 - ~~No. 1~~ This is below the  
lower end of the rapids of Itacutiara.

The wind is light. Our canoe men take the shore or  
Canoe Channel. The steamboat channel 200 ft to  
the left as we ascend is all right - and with a  
little more wind we would have sailed right up.

As it is we pole - and at the first break our four  
poles got out and pulled. The mokes had heads.

10:10 At the second break they poked thro' barely touching.

10:35 - In sound coming the channel obliquely 7-7-6 3/4  
6.5 5.5 5.5 5. 4 4 4 4 3 1/2 3 1/4 - channel.

11:00 Still running a N.W. Course parallel and near the  
long bar, which in Hatfield's map closes with the  
shore for a long dis. on Bahia side - but which  
has water behind. Part of the bar 1/2 of the way up ap-  
pears to close with the shore.

The mokes shown in the Pernambuco side at 11:00  
make 1/2 or 3/4 mile above this long bar is merely the termina-  
tion of a long ridge - elevates some 200 ft or 250 ft  
above the river - course about S.W. + N.E. Some points get 50  
ft higher.

11:30 - Opp. up. end of the long bar. Considerable water  
apparent now behind it; but possibly with the run 1 foot  
lower it would shut all. Off. It is of no consequence  
the Channel is good. Nothing is needed to be done

11:53 - Strike lower end of rapids - <sup>sounding</sup> 12 m. 14 m. 14. 15-16 3/4

12:05 - The wind being rather weak we began cordelling - 2  
men out on the rocks & in the water - Itacutiara Rapids

We tried the current. We could just about hold - but not  
go up. Our current measure gave 2, 45 -  
day 3 1/2 miles an hour. With a good

Tuesday Sept 16.

(147)

breeze we could sail right up mid channel; which is  
very deep (as our soundings show) and wide 250 to 300  
feet wide clear of rocks. A splendid steamer chan-  
nel.

After cordelling a little while - we sail a little way  
from the strongest current with a mild breeze -

The Channel in the middle at the least place is at  
more than 3 meters - our soundings in the Channel  
show much more - Current strongest in track,  
4 miles an hour, but we were going about 2 miles an  
hour - We may be certain that the current is not over  
4 miles an hour that any size or shape steamer will  
meet -

Above the first set of rapids is about 1/2 mile of  
wide clear water of great depth + moderate current -  
from 8 to 11 meters when in ran. Mr. Hatfield's  
map and soundings are very well.

12:37 - Strike lower end of work part of the  
rapids (200 meters)

12:55 - We are fairly above the upper rapids of the  
Itacutiara One hour!

Our motion has been chiefly with the sails, and  
my night breeze - although our four Indian  
poles, whenever they could, with a good breeze  
we could have sailed through easily.

On the upper lens, the Channel, in one place  
is narrowed to about 50 ft. Clear of rocks  
& formation rock - on the left. There is also a  
bend to the left in the Channel as we ascend.

The strongest current for a steamer to meet in  
mid channel will not exceed 5 miles an hour -  
Nothing is needed for steamer ascending, but  
for descending steamer it would be better to  
have some three points marked with strong  
iron columns set in the rocks; and to answer for a  
higher stage of water.

If my appearances, there is a steamboat



Channel on the Bahía side much wider, and although it looks rapid, it will probably be a better stream channel, on account of being straighter.

I can say that I can run a steamer up and down these rapids without having any thing whatever done to them; and that nothing more than I have indicated, should be done - at first.

1.15 P.M. In a wide pool <sup>our</sup> Course nearly North a handsome sweeping Curve to the East above here sailing with quite breeze -

viewed from the water the scene along here is almost a counterpart of the Delaware between Bristol & Florence - It is over 1/2 a mile wide of clear water - and about a half mile above here on the Bahía side is a sandy hill 80 ft along shore just like one of these Jersey hills - But - if we go on the flat - the state of things is very different.

1.32. Breeze freshens and our rate <sup>increases</sup> from 2 to about 4 miles an hour against the current with the Papogaia Mt. in sight about 4 miles ahead bearing a few degrees East of N.E. from here - within 500 ft of the Pernambuco shore. Sugar Cane, on the slope of the bank - Per. side. Cultivation meagre for two miles along on Bahía side -

Rice - Sugar Cane - Mandioca - & Beans. Look more like plantation work than anything this side of Albra. Still it is all on the marginal edge that will be flooded by the rain in November.

1.55 - Sails flap - We have passed around point of the bend - and the wind has died nearly away -

We begin boiling - Seals furled for the first time to day.

2.01. Sails up again - 1/2 miles an hour - against a 1/2 N. Cur.

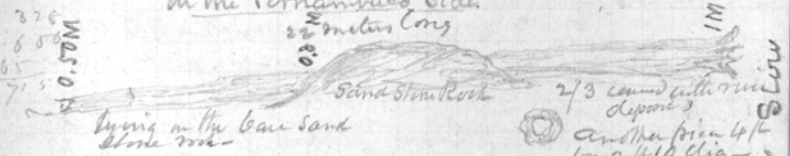
2.10 Sails furled - deep water spring - amphibious caform.

2.15 2 rocks above water. 300 ft from shore

2.20. Lower end of a little Bay - Campinhos de Cima

We stop to examine a fossil tree - The <sup>first</sup> ~~first~~ geologist - Cell relic ever seen - we measured it - it is 22 metres long = 72 1/2 feet - about 1 metre in dia near the roots, which are perfectly plain - 0.80 metres dia. half way - and 0.56 m. dia. at the broken end near the water's (low water) end - this tree has been not less than 60 metres high - nearly midway there are two feet of thickness of sand stone rock over it all now forming one solid mass; but the remainder of the trunk is distinct - the butt end partly imbedded in sand, the small end is lying on the sand stone rock just as if it had fallen recently; but the ages have passed since.

2.47 Start - a gain - morning, hot - sun - no wind - The anne is ahead with 2 scullers - The Cook & Left, Piranha - on the Pernambuco Side



3 1/2 P.M. - all the way from the big fossil tree to this place there are numerous remains of fossil trees - and just here quite a collection of beautiful fine specimens for Museum. Very very - slow going now - no sails - deep

4.15 - 2 knif-edge black rocks - 40 ft from shore of low water.

The wind failed, and we had to run and pole up the pool - my study - at the last a little breeze brot us in to Papogaia - at 5.40

at 5.40 - P.M. - just as the sun went down, almost exactly camp the river from here - League - 307 - Encampment N° 4.

Having come in all to day - 4 1/2 Leagues - 2/3 of the day with sailing = 13 1/2 miles = 22 Kilom.

The sun was very warm half the day; but the days work has been very satisfactory both financially and geologically - The great fossil tree - is Grand!

150 Tuesday Sept 16 (16<sup>th</sup>) to Papoçza.

CAMP, N<sup>o</sup>. 4.

REPORT N<sup>o</sup> 2 L. 307.

There is already a good navigation without any work - for propu steamers from Sobradinho - when, in encamped last night, to Papoçza - 4<sup>th</sup> Leagues

In the rapids of Itacutiara, I would have marks at 3 rocks, in order to show the channel for descending Steamers and to show it in a higher stage when these rocks are covered -

The current to be overcome will be from 3 to 5 miles an hour, with ample depth and ample width 200 ft. or more excepting one place where it is crowded by rocks to about 40 to 50 but very deep.

It is possible that the Channel toward the Bahia side may be a better one than the one we examined - in certain stages of the river.

That point must be decided here after. I am well pleased with the result of the days examination.

W. M. R.

6.10 P.M. - newly dark -

PAPOÇIAO

Our tents are pitched at the House of Sr. Justinho <sup>the name of a few town</sup> our Camp for the 12 animals have been brought from about a mile below.

I have concluded to go with the horse from here to Sorababi while the agouzo go around the pools to the same point

Wed. Sept. 17<sup>th</sup> We break Camp N<sup>o</sup> 4. this morning 157

Mr. Derby, Mr. Saboia and myself with Antonio for Cook and Manoel (of the Guard, who was with us on my other land trip,) and one other of the Guard, to be in my special party.

The Guard will also go - taking charge of the other six horses -

My object in this arrangement is twofold: to see how matters work in the boats in my absence and to make an examination of the Pernambuco branch for 2 leagues above Sorababi - and perhaps further.

The Munira <sup>at 8.10 they dropped round pt. about</sup> and Anna started at 8.20 - but the wind being across and not up, they went to the Bahia side - and got off - about 9.40 - We then took breakfast (Saboya, Derby and Anto. Manoel)

9.50 Start - with the Guard. Mr. Derby rode back to Reginho and rode slowly - a very hot morning. I went ahead for a mile or two - then Mr. Saboia and Casa the Came up <sup>of the Guard</sup> We rode on slowly till about 12.15 when stopped to wait for the pack train - By and by, Mr. Derby came, with his men - about 2 1/2 P.M. - very hot - at 2 P.M. Ther. in shade in the house 56° Centigrade = Fahrenheit 97° - In the Sun at 3 P.M. it was 56° Centigrade = 133 Farts. with sun. our pack-train not coming, I sent a man back - on my horse, to see and help them if he could.

I then went to the River about 1/4 mile from the house across a dry arm of the river <sup>in which</sup> which has been in com. cut. a beautiful granular beach. I saw the agouzo on the other side, 2 miles up, at 4 P.M. - They were a league above here down on the Bahia side, going slowly - [a colored man and boy came along in a canoe]. River 3/4 mile wide in flood - a little less now - Course for a mile or more here N. S. W. at 5 P.M. The pack train came. with one iron ore back horse, and one dark horse. Short 3 Leagues

3<sup>d</sup> Visit to Sabuca.

This time, by Compulsion - on account of the delay of the pack train of 3 animals and the great heat of the day, and our late start, which was unavoidable, on account of the necessity of dividing the provisions and re-arranging the storage in the ajonjos. We went up at 5. A.M.

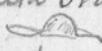

[I think our ajonjos - will make 4 $\frac{1}{2}$  or 5 leagues to day] I defer my report about Papogara till I meet the ajonjo party at Sorobabe - I hope to morrow evening.

Note - Sun Ring! to day, at 10<sup>h</sup> o'clock, was the finest I ever saw - a full ring, with all the prismatic colors - and all the space inside of the ring being a decidedly darker shade than the clouds & heaven outside. The ring was very large - I should think, <sup>apparently</sup> 200 diameters of the lens diameter - It gradually disappeared - evaporated, about 11 o'clock. It was within about 15 degrees of vertical. The day then became very hot. Of course there was some moisture in the upper atmosphere to cause this ring; but not enough to induce rain.

I can perceive daily, a gradual increase in the warmth of the air, and in its dryness - though it is not yet dry enough to cause suffering.

Meanwhile, the river flows majestically and quietly by, with a current of 1 $\frac{1}{2}$  to 2 miles an hour -  $\frac{5}{8}$  of a mile wide of varying depths. Sounding of ample depth of Halford's Map all along, on the Bahia side. I think there is also a good channel on this side. no Camp - House.  
Sunset Say 18° North of West, at 5.58 P.M.

Mem. As a rule, all the <sup>riding</sup> horses are small & thin (the dogs are still thinner), they are active and endure much, because they have to. The food that they get is much stronger than grass and they don't get enough of that.

The men all wear leather hats and leather <sup>(Coats)</sup> of a brownish red or reddish brown - all cut after the same pattern - the hats  made in a block. The roundabouts usually have one loose arm and often both.  home tanned leather and home made cut. I should a suit should last ten years.

No wagons, or carts, as a rule are used. We did meet 2 ox carts with solid, wad wheels the roughest of the vehicle kind I ever saw. The wheels may have approached circular when new. There may be some more of these non descripts.

Thurs. Sept. 18<sup>th</sup> Sabuca to Sorobabe 2<sup>d</sup> Visit

We crossed the party at 3 $\frac{1}{2}$  A.M. intending to make a very early start; but with much preliminary fixing, before we left the house of the widows, 6:20 A.M. had come - then for an hour we were stopped fully half the time fixing the pack. It was at 7:30 before we were fairly underway - a couple of miles out - We then jogged along well enough over the same track that we came out on the 4<sup>th</sup> of Sept. - just 2 weeks ago -

At 9:10 we pass the Pajon River - see the same 2 little farms in the bottom of the valley - two years without water enough in it to stop fording except 1 day - Pajon river has not been dry quite as long as the Moxoto.

Oct. 9.30 - we are on the Red smooth plain -  
at 10.15 we arrive at Sorobabe.

154 Thursday Sept. 18. Sorobabe 2<sup>d</sup> Visit

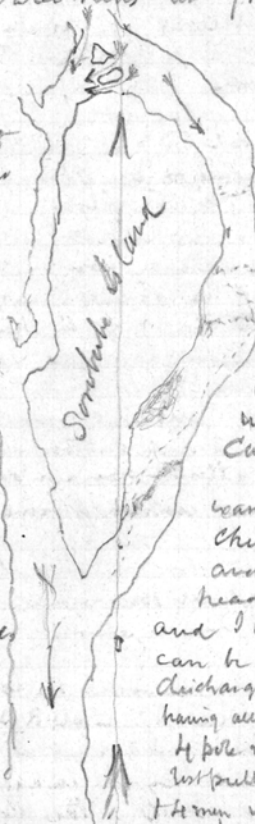
We arrived at 10.15; but it was nearly 1 before we had dinner.

Immediately after dinner I went in a canoe across to lower end of Sorobabe Island (which is about 2 1/2 miles long) and then walked up along the Pernambuco side examining the Channels in order to ascertain whether we were liable to unload Cargo in order to pass the Chutes in this Branch. This branch is wide 400, 500 to 600 feet in places, and it has three rocky ledges across with little openings through which the water runs at present.

I noticed at the head of this Island, that a large volume of water nearly or quite equal to all that flows down the Branch below flows out from it, between islands at the head, & runs over to the Bahia Channel and is then lost to the Branch.

Inexpensive dam low crib stone, will turn all the low water from to the Pernambuco Branch below the head of this island.

I was uncertain until to day which way the water ran at the head of Sorobabe Island. Harpell's map shows the Island & Channels very well, but it does not show which way the water runs in a low stage at the head of the island.



The water has fallen considerably since I examined this Channel 2 weeks ago. It is possibly 1 foot lower.

It is now a question whether our Canoes can go up without unloading Cargo.

I have today examined all the Chutes ground bars and ledges to the head of the island - and I think our Canoes can be gotten thro' without discharging Cargo by having all hands out wading if pole men are all the best paddling with the current & men in the water pulling on the boat.

Thursday. Sept. 18. Sorobabe, 2<sup>d</sup> Visit 155

near 299 League

It was excessively warm to day - I hid my coat in a tree, and carried my white umbrella - I walked about 5 miles on the island, including some distance along the head toward the Bahia Channel - to be sure of the volume of water flowing out that way.

I am now quite confident, supposing the water to be within about 1 foot of a low stage - that a good Channel having 4 feet depth of water - say 40 ft. wide with a velocity not over 5 miles an hour can easily be secured by low crib dam - or low crib dam with Chutes - along the lower 3 miles of the Pernambuco Branch; and perhaps 50 feet wide 5 ft deep without any great cost -

A Channel 50 x 5 x 5 miles an hour = 440 ft per min = 100,000 cubic ft. per Min - or only 1/20 of the assumed low water flow.

There is now flowing down this branch - say 200 x 5 x 2 miles an hour = 176 ft per 251,600 cubic ft per min. Supposing 1/2 of this should disappear at extreme low water with the water stopped at the head of the island there could be made enough for a Channel 100 ft wide 5 ft 5 miles an hour.

But without some improvement - even canoe navigation is almost destroyed in consequence of the water being scattered - over a width of 500 ft - running over bar and ledge - instead of being confined.

I must now see the upper league of this branch, as in all probability this is the side for the steamboat navigation.

I returned to the foot of the island at 4 P.M. - and saw that the MILNORA with Sen. Amarante Ho - had just arrived. The ANNA came in not long after - and we all encamp here to night this is regular camp No 6 - the boats have camped at No 5 - Tapera de Cima near 302 League

Camp No 6

REPORT No 3.

307 league to 299 L. = 8 Leagues  
A good Steamboat Channel all the way.

We are now <sup>approaching from below</sup> near the foot of the rapids & falls of the Cachoeira do Vão.

The <sup>of the branch</sup> 2 miles that I reexamined this afternoon - embrace that much of the rapids, and will be a part of the improved navigation of the Pernambuco in shoes to select for the lower 3 miles of the improvement.

Camp No 6

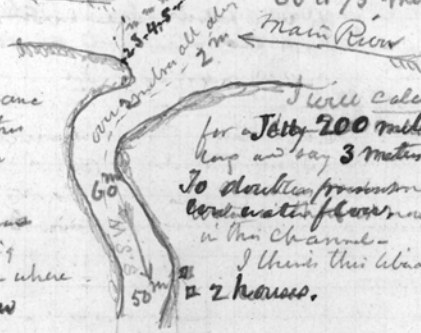
Friday - Sept 19 - 5 1/2 A.M. - awake and started. Mr. Duty Saboia and I are to go up this morning about 7 miles to the extreme upper of Is. Cuite to examine the Branch (Pernambuco side) above when we examined before - as usual when apparently ready, there is some detention.

6.15 Start - at 8.10 we cross a Saline Stream - it is not flowing water now, but has pools of water which has a taste of Elixirs of Iron & Salt - Salt is made here in a nice way - each tributant along the river making it suit himself.

At 9.15 - we arrive at the two houses within about 1/3 mile of head of Ilha de Cuite and we see nearly to the upper point - Here we breakfast - a good one

We turned in about a mile back and found a nice clean channel 150 to 200 ft. wide bottom. Slime + mud - Clayey alluvial banks - fringed with Copra near the surface of the water and the customary growths on the slopes - very favorable, indeed for a Steamboat Channel.

After breakfast we cross over here where it is about 150 ft <sup>or 50 meters</sup> at the elbow - but just above it is 200 to 250 ft wide around the elbow. 60 to 75 meters.



There is a good entrance of 100 ft width or 2 meters deep at this stage, and the Channel carries over 2 miles down to the house. The narrow place being about 70 ft of that depth - where there are some rocks now under water.

From the appearance of the river there is no difficulty in running from the mouth of this Pernambuco side Channel to the main Channel in the River say 1/2 mile to mile above Rodellas - afterwards examining G. Mr. W. Saboia and found to the large Church of the Missões at Rodellas is in full view, about 2 miles off - a little down Stream 1/2 mile or more from where we are.

I <sup>just</sup> ~~start~~ <sup>start</sup> out in the Canoe with our pilot, and <sup>and also</sup> ~~started~~ <sup>started</sup> down from the mouth to the house, full 1/3 mile - We finished about 11 a.m.

Start back - now down stream now.  
Start back - at 11.40 a.m. 12.05  
1 1/2 miles below head of Channel is a Cachoeira  
Bear channel in Island side -  
Skip the other rocky chutes  
Some few Rocks to be head \$5000.  
2 ft fall in 100 ft only 2 to 2 1/2 meters now in the (1)

One fourth mile below 12.20 P.M. (in fact) and the 8 inches is 200  
(2) Fall - gravel. Carily fford. 2500 to 3000 ft

12.25 1/8 mile below the gravel fall is a rocky  
(3) obstruction 6 inches in 200 ft. Area 200 ft wide  
Clear all way 40 ft with down any the way  
2500 to 3000 ft some Rock to 2 ft below

(4) 12.33 - A small one 1/8 mile below - but a fair channel in  
an island side for small steamer.

(5) 12.38 1/2 mile below - nearly like the first one - 18 inches fall  
for 500 ft. The first channel in island side  
takes a drop 20 feet or more long, 5000 ft.

12.45 - Lower end Cuete Island - Upper end of  
Cabaces - Here the water that flows from the  
main river in the other side of Cuete island -  
a large volume - all comes in - at a little higher  
stage some of this water escapes to the right, and the  
islands - a slight dam would remedy this.

1.05 - another fall - when the river is 300 ft wide 1/2 m.  
above the Cavallos falls - Rocky - Channel  
nearly main land 12 inch fall in 200 ft 5000 ft

Then some rocks to be blown out to make good navigation  
Main a great supply of water - but it must be carried  
5000 ft low

1.20 Cas de Porto Velho - Porto Velho  
It is half a mile below where the  
large body of water comes in and below the  
pt. of the island.

About 3 ft fall in 400 - The way to improve -  
a low dam at the head 350 ft long, and then a  
Cuete channel one 250 ft wide 200 ft long for a  
good steamboat channel there is water enough  
some rocks to be blasted. 20,000 \$-

Pilot call this Porto Velho Falls - Write this with map

1.40 Opp. pt. of Island Espinheiro where channel comes  
in from Rondeller - nearly channel

It is three or four id this side channel - the area  
below at least 1000 ft wide - plenty of water  
and a channel - We will see this as we come upon  
the Apurizos.

The general result of my examination of the Branch on the  
Permanente side is that it is entirely practicable to  
make it into a steamboat navigation in low water -  
say a Channel 3 feet deep and <sup>20 inches</sup> wide, with a  
velocity not over about 5 miles an hour. (say 9 Kts.)

As nearly as I can ascertain, the water is now  
within about one palm, or say 9 inches of extreme  
low water, along these rapids.  
More water is needed in the branch from the head of  
the island Cuete down to the lower end, where it now  
receives the water that runs between the island Cuete  
and Virva das Cabaces.

This need can be sup-  
plied by building a dam or jetty from the head  
of Cuete island to intercept 250 m. of the  
low water flow of the main river, and turn it into  
this Permanente Branch.

In addition to this, there are some  
minor Cachochiras in this Branch which need  
tracing so as to confine and guide the  
water into one Channel. [see previous notes Page  
157-158]

In ascending out into the river opposite  
head of Cuete Island - with a pole 8 ft long, it did  
touch for about 200 ft. of the length. Of course I do  
not yet know the depth there, but I am of the  
opinion that for the dam or jetty, if we  
call 150 meters long x 4 meters deep x 3 meters wide  
it will be safe = 1800 C. meters say 2000 c. m.  
at 20¢ per cubic meter = 40,000 \$ 000 - including  
timber and stone -  
100,000 \$ would make the channel thro.

Soon after breakfast, and just after all of the  
Enginiers except Sr. Sabria and I, The mail man  
came with letters and papers for the Commission  
sent by Mr. Kruger, our mail man had del<sup>d</sup>  
the mail we sent; but he had not made his  
appearance again.

Letters from Sr. Kruger,  
Col. James, and Mr. Roberts. Aduis letter refers  
to letter from Milnor Ban and Animi - and  
Mr Bogart, and circular from Edwin M. Lewis;  
Inspector, and Beecher + Benedict # 3. Mourana re-  
ceipt, also mention letter from Mr. Harrah en-  
closing my interesting newspaper slips - one  
concerning an interview with Capt. Eads  
quite important to me.

After reading the  
letters and newspaper slips, I proceed to  
write letter to Addre- to  
Col. James - Capt. Eads - C. J. Harrah -  
Mr. M. Lansdale, Beecher + Benedict en-  
closing them my check for \$3. Mr Roberts  
having the receipt full, return them the  
other, bank bill. [ I wish to note here, that  
the value of the goods insured for \$1500 is  
materially less pecuniarily than that sum, as  
many have been removed since the first  
insurance when that sum was correct ]

Also a letter to Chief Eng<sup>r</sup>. Kruger, in ans-  
wer to his of the 17<sup>th</sup> rec<sup>d</sup> here to day - as  
follows -  
Dr. Remaldo Van Kruger Sorobabe, Sept 20 - 1879  
Dear Sir.

I am very much obliged by your  
kindness in sending your mail man with the  
mail matter of the Commission, together with  
your letter dated 17. Sept. for which please accept  
the thanks of all of us.

I note the contents of your letter, and I hope  
you will secure a satisfactory understanding with

MEM. for a Cow - 2 animals called. \$0 \$000

The government respecting the launch.  
The only thing that seems to call for  
advice or suggestion from me, in the above  
connection, relates to the fireman.

Not having employed him or authorized  
his employment, I am somewhat at a loss what  
to advise. I suppose that Sr. Rodolfo thought  
he was doing right when he engaged him.

I would suggest that the fireman's wages  
be paid from the day he was engaged till the  
day of his discharge; that is, as soon as you find  
that there is nothing else for him to do. If you think  
it proper to allow his time and to pay his  
expenses back to Penedo, I would not object to that.

Under the circumstances, I think it is  
better to adopt your suggestion of having two  
men to act as Corniers between Piranhas  
and the Commission. One man will go  
down with your Comy in time to start back  
on Wednesday or Thursday next with mail,  
the other to leave us, wherever we may be,  
in time for the mail of the following week.

We may perhaps leave here tomorrow,  
with our ajorijos; but we do not expect to get  
farther than Rodellas, the day we leave here.

With kindest regards for yourself and your  
staff  
I have the honor to  
M. M. Roberts  
Eng<sup>r</sup> en chef

P. S. The man whom I send with the  
mail in company with your mail man, is to be  
at your Command during his stay in Piranhas.

The engineers who have been engaged  
on the Bahia side, running levels, and  
transit etc, having made partial report I  
conclude that I will go over myself,  
again, tomorrow, and verify, and get a better  
idea of the falls, pitches and rapids.

Cloud letters and made up mail for our Councils - and left the package in the hands of Sr. Amaranth, thro Sr. Lisboa - who had translated my letter Mr. Knicker;

Then, with Sen<sup>r</sup> Castro & Peçoqueira and the Indian crew I went over in the "Anna" to the Bahia side and Superintended the leveling from the poove below the Falls <sup>1/2 mile</sup> about the lower end of Sorobabi island.

P. Sight	Fore Sight	Cor -	Height above Base	Dis. in Meters	Remarks
	metri.		0.000		Surface water below lower rapids.
3.320	2.568	+ 0.76	0.76	250	
3.010	2.74	0.27	1.03	350	* This between the 2 <sup>d</sup> rapids & the big fall.
3.51	3.36	0.15	1.18	500	
2.37	2.28	0.09	1.27	600	at foot of big fall
3.18	1.81	1.37	2.64	800	nearly. Fall 4 1/2 ft here
	Heavy pits nearly vertical for 3/4				Total fall in first 1/2 mile 8.65 ft.
2.57	2.20	0.37	3.01	1000	about. opp. strong pits
3.41	2.76	0.65	3.66	1200	at head of 2 <sup>d</sup> big fall.
3.22	3.11	0.11	3.77	1500	Opp. a Cay <sup>a</sup> running to the left of rock islet to meet water coming from the Pernambuco side - head of Sorobabi. This water comes in below to the Bahia Channel again.
2.53	2.36	0.17	3.94	1600	Opp. 5 M. on lower current. 200 feet wide between the ragged, black rocks.
	Opp. Cay - Cross a dashing torrent among the rocks to the left - of a rough rocky island. on the Bahia side of the island, the channel is smooth.				
	Here the water meet from the two sides of the River.				
	about opp. low end S. Miguel Island.				
3.78	3.62	0.16	4.100	1690	Day Falls 5 M. is 2 1/2 S. K. 16.4 8200 1.55 M
2.36	2.26	0.10	4.208		
0.83	0.00	0.83	5.038	2500	Surface of water 1 1/2 K. from lower end

We returned about 3. P.M. - a barq<sup>a</sup> pama - down a few minutes after we arrived; but I missed an examination of it, supposing it was the one we had chartered up to Caboto's; but the men say it is larger.

From the examination now made I am quite ~~convinced~~ <sup>convinced</sup> that the steamboat Channel should be made on the Pernambuco side of the island of Sorobabi. The only point to be determined is how it should be located above that island; whether on to the Bahia side along the regular Cangi-Channel, or all the way hugging the Pernambuco shore, or through the Channel on the opp. side of Island Cruz, a small arm. Our trip tomorrow over toward Rodella may settle, or at least help to settle this question.

Monday Sept. 22<sup>d</sup>

Farewell to Sorobabi & Sr. Domingos (Francisco de Rezende)

6.45 A.M. Start - To go up Pernambuco side - the regular Canoe Channel, 1<sup>st</sup> Rapid or swift about 1/4 mile up above ft. of island. 7:00 This is formed by a gravel bar from the Pernambuco side through the Channel close the island. Full 5 mile an hour current. Had to out port<sup>n</sup> & double team.

7.50 2<sup>d</sup> (gravel) rapid or Swift about 1/4 mile farther up - 2 channels one on each side of the Branch "Anna" in island channel, Milnora on shore channel. Bar is within 1/2 palms of being. The water can be concentrated to the island - channel by a small dam 200 ft. - 5 ft. high - 3 mile current now.

8.05 - Some of us in board<sup>n</sup> again. Canoe men in the water hand-pulling. One man went to the Anna



Mon. Sept. 22<sup>nd</sup> Along Sorobabe Channel.

On a little got out again, and walked up island, passing two small rapids to the falls - where obstructed by a chain of rocks, the river falls in numerous little channels about 1/2 a meter. The present best canoe channel being close to a small rock on the island side.

This chain of broken ledge of rocks runs obliquely across the river on a length of 800' or over - Course 15° North of East.

General course of river just here about S. but curving down westward.

A good steamboat channel 60 feet wide can be made here, at A.

~~Point~~ A below one <sup>with a little more work</sup> near the middle of the river - Coffin dam in 5 ft. water throw out not over 50 c. inches of rocks and make a chute 5 to 6 ft. high 200 ft long of cut stone. Then fill all the principal indentations when the water now wastes on the length of 800 feet - and make it into

a dam with stone and timber, averaging not over 3 ft high, which will throw all except leakage (which I could not attempt to stop) into the one chute. Then, with the additional water to be thrown in above the head of this island, there will be water enough for a 5 ft. x 60' channel.

at 9.20 AM <sup>the</sup> "Milnora", "Anna" and "Milnor" <sup>Falls</sup> arrived at this.

at 9.35. Had passed all 3 up - without unloading. I had said, that, I thought it possible. It was just as close as I desire to see; but the men worked royally; and it was well done. 1 1/2 M.

We now take breakfast - in honor of the occasion.

The barge "pagette" with our goods, which preceded us some 5 days, when the water was better, unloaded here.

[I shake hands with an old Indian - grand-father of our bright young canoe-man - said to be 100 years old.]

10.55 - after Breakfast - Start - make chute below <sup>100 ft. deep</sup>

11.02 Small rapids ledge 500 ft across - <sup>small dam to</sup> close waste - pretty fair channel now 60 ft wide below <sup>higher</sup>



Mon. Sept. 22 - Along Sorobabe Channel.

We pass it readily - we have 5 poles on just now.

11.08 another, much smaller, <sup>(swift)</sup> semi-ledge arch, and a pretty fair natural channel near middle, near the island side: small dam coming 300 ft. no artificial chute needed. Cause of R. about 20 N. [Mr Weiser and Lisboa took Sec. of River here yesterday - or the day before.]

11.30 - There are a few rocks in the river along here which had been removed, or else marked.

11.35 Rapids - 2 sections 6 inches each - 100 ft apart. Some few rocks to be removed - a low dam 5 ft to confine the water - make channel near the island 60 ft wide - make a chute abt 200 ft long - Good poles down in passing up.

11.40 opp. the waste channel above the head of Sorobabe islands - a dam 300 ft long 5 ft high - to stop the waste which now goes to the Bahia side.

Another dam 400 ft - on the other side of the island will stop all the waste here. Some rocks to be removed, or marked.

11.55. This is a bad place in the river - which about 1000 ft. wide, full of little rocklets, islets, most of them with bushes on - and rocks under water. A channel will have to be selected here, and rocks removed - and others marked - and ~~perhaps~~ a few low dams to concentrate the water.

12.05 - We are now running thro. the channel between S. Antonio, and the small island (interim) before S. Miguel, Island - (to avoid the Cap. de Espina nos - along the Pernambuco side.) <sup>crossed rocky 150 ft to 100 ft wide.</sup>

[This is not a channel to be improved; but its water may be turned in to the Pernambuco channel.]

12.27 We strike the wide channel below S. Antonio and S. Miguel.

- 12.40 at Point of Island Bovi - little island between San Antonio and San Miguel.
- 12.50 This channel is 500 to 500 ft wide - <sup>irregular</sup> much obstructed with rocks & small chutes - a strong volume of water flows down here and runs to the Bahia side which by damming can be diverted to the Pernambuco side.
- 1.03 - now we have turned to the right, up a steep little pitch in between the small island Pao Jaco + S. Antonio - we used the cord to make the pitch - we use less
- 1.07 - in an 80 ft channel - with little pitches.
- 1.15 - a hard pitch - 3 passages - we took the smaller - and with a cord + double team we just squar up - all hands on shore on the rocks etc.
- 1.33 - all the boats are up at the head of S. S. Antonio - when a channel runs off between S. Rodonda + S. Antonio - the water going to the Pernambuco side. Saw dam of 300 ft + high in 30 ft. more circle turn the water over to the Pernambuco channel that now runs
- Canoe - came from Rodellas - takes Mr. Amarants, who is sick and Mr. Pecigana - to Rodellas.
- 1.45 <sup>Start</sup> start up a pitch, with cord -
- 1.58. Opp. upper end of S. Miguel - Channel across to the Island Jacumbi - 138 meters - measured and sounded by Mr. Weiser and Sierra. Depth 4 meters - current moderate - water runs over to the Bahia side. If this water should be necessary it can be taken along beam, this side of the above water when it is shallow - say 700 ft long 6 ft. high it is a large volume of water. The river is here full for miles wide - the regular channel running from Rodellas across to our right, to the main land Pernambuco side. See map - shows this very well.
- 2.10 We hoist sail - wind moderate - puffing.
- 2.22 Opp. lower pt. of Cabacos Island - River nearly half mile wide, deep, slight current.

- which runs over toward Rodellas; ~~the~~ now in the regular boating channel which is nearly to the island <sup>Jacumbi</sup> ~~Jacumbi~~ we are near the Island Urcubi.
- From here it runs obliquely over to the Pernambuco shore deep and wide - to where Mr. Weiser + Sierra began their soundings the other day - It is a good Steamboat Channel back from here to the Pernambuco side - for Steamers drawing a metre or something more - This wide channel does not admit of material change without considerable cost; but if it holds as good as here, to the Bahia side, it will do.
- 2.40 we leave the main channel and go off to the right among small islands, where there is only a Canoe Channel - The reason assigned by the Pilot that the main Channel is too deep. I will have to see this main channel, either this evening or tomorrow morning.
- 3.05. Between the Little Island Cabacos and the island Tucum - in the main channel, but on the Canoe - land side of it - there is a good Steamboat navigation from here back to the Pernambuco side.
- 3.20 we are poling our way in and out in the Canoe Channel among the rocky islets - with an occasional little Swift - the main channel being over to the left - with deep water - up to near the Cap. Two do Ocho.
- 3.43 - We have just worked up through one of the hardest pitches we have had. The main channel is now off to our right, the pilot says it is deep, and it has that appearance, and Hall's soundings show nothing less than 9 ft. in the Channel. <sup>Some</sup> It runs over toward the island Urcubi.
- 4.10 We are now in or near the rounded channel shown on Hall's map, <sup>rather</sup> ~~rather~~ has a mile of the or distant shore from this point. <sup>Some</sup> ~~Some~~



Mon. Sept. 22 In the main River now. Rocks, Rocks!

158  
4.13. The water comes down on the left side of Island da Porta and turns and runs up stream, and we actually descend directly up stream, through a small chute in the Canal Channel.

4.23. We pass up a small rocky chute - without trouble.

4.32. Now sailing among the rocks - about to arrive at Rodellas - town just ahead.

5.05 Arrive at <sup>the</sup> Upper end of the village of

### The Missão Joao Boga do Rodellas. League 297.

The name looks and sounds much more imposing than the village betokens; although it has two Churches; but no padre.

It is nothing more than a village of Canoe men and their families. No Store or business house here. Our landing place and encampment is nearly opposite the head of Ilha da Porta.

We are now almost directly opposite the head of the Island of Cuite where I was on Friday Sept. 19<sup>th</sup> in Co. with Sr. Saboria, and Mr. Dealy.

Here we have a river nearly two miles wide dotted with little islets some of them green with a sort of willow growth, all of them rocky, and many of them merely bare rocks.

Our tents are pitched under a peculiar looking tree, called the Quiyabeira this compound of many kinds combined - the whole making a mass about 7 feet in diameter. The tree has handsome foliage - though the leaves are quite small.

### Report No. 4

Respecting the Channel for a Steamboat of light draught, between Rodellas (or this part of the river) and the lower end of the Island of Soro-baba - from whence we came to day, are satisfied that it can be made; in two ways; one way down the Pernambuco Branch, which

Mon - Sept. 22<sup>d</sup> Rodellas - Evening. 169

I examined on the 17<sup>th</sup> (and in part before) the other way by following the general route indicated by the Sandings as far as they are given on Halford's map, and then down the Pernambuco Branch. Supposing them correct.

These are to be studied and Calculated hereafter. I have merely made such observations and taken such notes as will enable me to study, and compare, and decide, after I shall have become acquainted with other parts of the river above here.

I make no decision of route, or dimensions or estimate of cost at present.

or will say about this: Report No. 4 - therefore says, that a light-draught steamboat navigated thro' these 7 miles -  $2\frac{2}{3}$  leagues - (being League 298 - 299 (part of 297) can be made. The cost will depend upon the depth which is to be guaranteed for extreme low water.

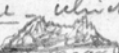
After my experience about these Falls and rapids, I give up the idea of making any attempt to improve the Bahia side, because either of the other routes is a much more feasible, and <sup>improvement</sup> will be much more useful. The objection to improving the Bahia side, are: that the distance is much shorter, making a much steeper slope, and the cost of transforming that part of the river into an ascending steam navigation would be very much greater than either of the other routes.

I will not say, that, if the other routes did not exist, that it <sup>would be</sup> ~~is~~ impracticable to make an ascending steam navigation all the way on the Bahia; but, owing to its characteristics, the cost would be very great; and the same steamer that could ascend on the other route, could not ascend on the Bahia side. The steamer would have to be more powerful and consequently heavier cost, just so to build and more expensive to run.

The details of the results of our examination of these  $2\frac{2}{3}$  leagues, cannot be made up till we have furnished our survey of the river.

## Rodelles.

After making inquiries of the pilots and Canoe men who live here, concerning the Channels, I have decided to remain here to day, and examine them.

Mr. Neira & Sibra will examine the one farthest out from the Bahia side, and also take soundings from the point of the island, Ceite out to the main Channel; while I with others examine the one nearest to the Bahia side. One passes on the other side and the inner one on this side of the great rock Uribie which fronts in front of the village of Rodelles.  Island.   
 Begin about 1 mile above the Church near middle of River.   
 about 1/2 M. above Id. C. S. Soundings - in Metres.

6 first soundings.

- |       |  |
|-------|--|
| 9.44  | 2 Rocks to right of good wide channel 1/2 m. deep  |
| 9.45  | Channel curves to right. 1 Rock on each side 50ft below 1/2 m. deep both still curves to right. now 2 metres                     |
| 9.48  | Clumps of rocks above water a few small rocks with 1/2 M. depth on them. a few rocks to be marked                                |
| 9.50  | Tangent then curve gently to left. 1/2 to 2/3 M. Channel clear 60ft or more  |
| 9.51  | Curves again to right 9.52 Rock both sides 80ft clear  |
| 9.53  | Rocks both sides. 50ft. 2 m. to 1/2 m. Now at once curve to left. 1/4 M. 1/2 m. 1/2 M  |
| 9.54  | top of road 1/2 m.   |
| 9.55  | Chute opp. tent - 1/4 - 1/4 - 1/2 1/2 then curves to left 1. 1 1/2   |
| 9.56  | Running over toward island. Ponta 1/2 now turns curve to right - 1/2 to 2 M. Now steering toward inner bay towards Semina we are |
| 9.57  | about opp. Church - angling gently to right 1 1/2 M  |
| 9.59  | Another gentle chute 60ft clear 1/2 to 1 1/4   |
| 10.00 | Just opp. Semina - 2 metres.   |

## Rodelles Sounding

## Hatfield's Channel.

- now turn to left toward middle - 2 metres
- |           |   |
|-----------|---|
| 10.01     | 2 to 2 1/4 M. nearly out to middle - wide 100ft   |
| 10.02     | 50ft clear 2 m. - 1/2 to 2 m. - semi rocks to be marked. <span style="border: 1px solid black; border-radius: 50%; padding: 2px;">Wind ahead</span> |
| 10.03     | wide, clear 2 Metres  |
| 10.05     | " " " " 1 3/4 1 1/2 M.  |
| 10.06     | " " " " 2 1/2 to 3 m.   |
| 10.07     | within 300ft. of Bahia shore  |
| 10.08     | 2 Rocks to be marked ch. 100ft bet. - 250ft from shore  |
| 10.08 1/2 | wide clear - 2 1/2 M.   |
| 10.10     | narrow 1 m. rocks 50ft - some little  |
| 10.11     | narrow - 1 to 2 m.  |
| 10.11 1/2 | narrow curve to left to show chute  |
| 10.12     | in chute 2 m. - 1 3/4 1 1/2 - 2 1/4 Hard turn to left. over toward corner pt. of Ponta Island - 1 m 1/2 l. deep to right of                         |
| 10.14     | narrow & shallow 1 m. given to come out   |
| 10.15     | ditto ditto 1. 1 - 1 1/2 1 1/2 with 200ft of island. 1 1/2 - 1.   |
| 10.16     | 100ft from island - 1. 1. l. pretty fair 1 m.   |
| 10.17     | in that up current - foot of island   |
| 10.18     | narrow 30ft. 1/2 M. to the top out  |
| 10.20     | 1 metre of Pedras with 1/2 m.   |
| 10.21     | side current - making for Bahia side 1 1/2 M  |
| 10.22     | good wide, clear 1 1/4 M. Pass 1 m. into lead fast  |
| 10.25     | good wide 2 1/2 - 3 -   |
| 10.26     | " " 3 1/2 4 m. 3 - 3 1/2 150ft. or more   |
| 10.27     | " " 2 1/2 4 m. 100ft clear  |
| 10.28     | " " 3 - 3 1/2 - 3 1/2 4 - 4 1/2 all the time widens to left a only minor  |
| 10.29     | good, wide clear 4 1/2 - 4 - 3, 3 2 1/2   |
| 10.30     | " " " " 2   |
| 10.30 1/2 | narrow to 80ft. Chute gentle 2 1/2  |
| 10.31     | 100ft. 2 1/2 to 2 1/2 swift - good.   |
| 10.31 1/2 | 80ft piece - 3 - 3  |
| 10.32     | wider, clear 2 3/4 M. turn to left.   |
| 10.33     | " " " " 2 1/2 approaching Cas. Caborda  |

(172) Tuesday Sept 23. Sounding - Halbid's  
in the "Milnora" Channel.

10.33- 80 ft -  $2\frac{1}{2}$  -  $2\frac{1}{4}$   
34 80  $2\frac{1}{2}$  semi chute - 3 - 4

34  $\frac{1}{2}$  Chute 80 ft deep. 3 to 4 m. Good

10.36 Hard Point in chute - only - This mild  
harms. Cabot's a chute to be clear cap.  
Urubu & Betta, & wider Channel, are left

10.37- Below Chute - 8 miles deep than 5 miles.

10.38- In wide, deep, Channel - 6 to 7 miles. 6

10.40 - Wide clear - 11 miles -  $12\frac{1}{2}$

10.45 <sup>good</sup> opp. lower end of Jacurubi Island. 14 miles to 5.

10.47 - in pool 2 m. opp. upper Jacurubi has

good navigation -

Approaching small chute along Jacurubi Id.

2.  $1\frac{3}{4}$   $1\frac{3}{4}$  - 3.  $2\frac{3}{4}$

10.49 chute -  $2\frac{3}{4}$  -  $2\frac{1}{2}$  (good wide)  $2\frac{3}{4}$  -  $2\frac{1}{2}$  -  $2\frac{1}{2}$

10.50 Below Chute 3 m. - 5. 4. (pool)  $3\frac{3}{4}$

Approaching another little chute.  $3\frac{1}{2}$

10.50  $\frac{1}{2}$  Chute - 3 -  $3\frac{3}{4}$  in chute (good wide)  $3\frac{3}{4}$

10.51 Below chute  $3\frac{3}{4}$  -  $3\frac{3}{4}$  5 in pool below.

10.53 Now we are in the main Channel  $3\frac{1}{2}$

Stop - Some navigation over to the

[my watch 8 minutes slower than Mr. Derby's]

We stop, opp. quite a large ham in Island - where  
dark colored peop. - some.

Upon the whole the Channel we have  
sounded is better than I had looked for.  
Although there are a few hard points  
in it; but a moderate <sup>is required</sup> seem to make  
it a clear 1 metre navigation.

Rest = 184 minutes


11.11 - Start back - men breakfasted

1.35 arrive at Camp No 7. We met the  
"Anna" going down the other Channel.

Tuesday - Sept. 23 - ROADELLES.

173

Evening - Camp No 7.

Report of Mr. Weiser (assisted by Sr. Lisboa) of  
the Channel soundings, of the other Chan-  
nel East of the  big fork Urubir - and  
of the soundings off the upper point of the  
Culte island - at the inlet of the Pernam-  
buco Branch of the river.

Messrs Weiser & Lisboa have just come back  
in the "Anna" (4 P.M.) having sounded a  
Channel from the same point (or near vicinity)  
that we started from this morning to the main  
deep channel at the Jacarubi - about where  
we stopped our soundings.

They find a Channel  
every where more than 2 metres deep at this  
stage of the river, and most of the way over  $2\frac{1}{2}$   
metres. There are only two places less than 2 metres  
and no where less than  $1\frac{1}{2}$  metres; and the cost  
a bronze in; the two places one  $1\frac{1}{2}$  the other  $\frac{3}{4}$   
metres, to 2 metres depth will be quite trifling;  
not over a few hundred milreis.

We are  
therefore sure of a Channel without any work  
whatsoever  $1\frac{1}{2}$  metres deep from the deep pool  
above Rodellas to the Pernambuco Chan-  
nel at the Island Jacurubi  $1\frac{1}{2}$  metres; or  
I may say 2 metres deep, with an insignifi-  
cant expenditure; but I would estimate a  
few thousand milreis to make the Channel  
straighter and safer.

Accordingly I no  
longer consider the Pernambuco Channel  
along the island Culte necessary to make  
a fair steamboat navigation.

The actual expense will be between the  
lower end of the island Jacurubi and the  
last chute (above the lower end of Sorobabi)  $1\frac{1}{2}$  League  
or say  $3\frac{3}{4}$  miles = 6 Kilometres. See page 174  $\frac{1}{2}$

## Memorandum.

After examining the Hatfeld Map Channel from a point about a mile above the Seminary to the wide, clear, deep Channel along the head of the island of Jacarubi - where it strikes the Channel along the Pernambuco side, I am enabled to say, - that at this present stage of the river (said to be within a palms, or within  $8\frac{1}{2}$  inches (at extreme low est stage) very little labor comparatively, is needed to make a steamboat navigation - say for a steamboat 100 ft. long, 20 feet wide drawing 3 feet. I could with the pilot - (Lewis) whom we had to day, run such a steamer up, now; but, in order to run her down, safely, some rocks should be removed or marked.

But, if I were required to insure a depth of  $1\frac{1}{2}$  metres, or say 5 ft. draught at extreme low water, the cost would be considerable, because numerous rocks that are now a metre below the surface would have to be removed; probably, in most cases, by blasting.

Page 174 $\frac{1}{2}$  of the Field Book.

The expense will be chiefly the construction of low-water dams, to prevent the waste of water from the Pernambuco Channel over toward the Bahia side.

The chief of these is between the islands Jacarubi (lower end) and the upper point of the island San Miguel; between San Antonio and Island da Crueira, (or across to the small intervening islands) in order to prevent the waste of water from the Pernambuco over to the Bahia side, and the training of the Pernambuco Channel, at the Cachoeiras, and little rapids, as noted in my journal of examinations of that channel. See Journal of Sept. 22<sup>d</sup> - and of Sept 3.

I am very greatly pleased with the result

## Evening - Rodellas

of an examination of these 7 miles! I am now sure that with one season's preparation, and another season's work, I can make a navigation  $1\frac{1}{2}$  metres deep that steamboats can pass safely up and down, between the lower end of the Island Sorobabe and Rodellas -  $2\frac{1}{2}$  leagues = 7 miles or about  $11\frac{1}{2}$  Kilometers - for not exceeding 250,000 \$000. to 300,000 \$000

REVISE

I consider that I have now reported from Jatoba to Rodellas = 17<sup>+</sup> leagues = 57 miles! Total rough approximation of cost of a  $1\frac{1}{2}$  metre navigation at low water on these 17<sup>+</sup> leagues - 250,000 \$000 to 300,000 \$000 W. H. R.

REVISE Evening Sept 23<sup>d</sup> 1879 -

We are to start with the ajinjos "Milnora" and "Anna" & "Melnor" at 6. a. m. tomorrow.

SEE VOL. 2<sup>d</sup>

1061.5

1030

31.5 Palms

.22

630

63

6.93 meters

List of Names - sent Sept. 7. 1879  
to Addis, to be sent by her to the Pitts Pot.

S. W. Roberts ✓	Mon. Dr. W. W. Wallis Carline Pa.	* M. Col. Yates ✓
W. M. Lamdale ✓		Jac. Heimbaid ✓
W. L. Roberts ✓		John P. Roberts ✓
S. C. Huey ✓		J. B. G. Roberts ✓
Mr G. Monkhead ✓		E. L. Vandew ✓
Geo E. Beebe ✓		H. B. Nathan ✓
Sagmt Wilkern ✓		Ben. D. " ✓
Hon F. A. Billings ✓		S. Kruan ✓
Mr F. A. Bueler ✓		Morris Dorrance ✓
Geo G. McClure ✓		Mr Gen. J. Baker ✓
John Duggan ✓		Gen G. K. Warner ✓
W. M. Roberts Jr ✓		" J. N. Maccomb ✓
Capt J. B. Lader ✓		" H. G. Wright, Chief ✓
R. S. Elliott com of Cadets ✓		" Mr S. Hardee ✓
Col. James Morrauw ✓		" Mr L. Ross ✓
F. K. Thurber New York ✓		Jay Cooke Philad. ✓
* Char. J. Richards Elizabeth ✓		* D. Joseph Klapp ✓
* Col. Char. McClure U.S.A. Portm ✓		
* Mr M. McClure Carlin Pa ✓		
Jatoba according to Kruger		281.52
calling low water at Perankas		31.18*
Diff. of level = 821.11 ft =		<u>250.34 M.</u>

M. Halfed given Jatoba 688 ft  
Perankas 58 ft  
Diff. 630 ft

821.11

630

191 ft difference

The main source of the Rio de São Francisco is in the eastern versant of the Terra da Canastra, the great central platform of Minas Geraes, between S. Lat. 20° 20' 30" and W. Long. 3 (Rio de Janeiro).

St. Hilaire gives to the Carra d'Anta Cascade 667 feet of altitude. Water West to East  $55\frac{1}{2}$  leagues as three mountain torrents. Before receiving the Paraopeba breadth 140<sup>m</sup> max. depth 3.28<sup>m</sup> - discharge 130 cubic metres per second. = [7800 C. Ft. per min.] Direction is then from S. to N. Serra Grande or Copinhaco on the E. and Mata da Corda forming the W. wall.

Paraopeba to Pirapora Rapids surveyed, it inclines first W. then E. dist.  $40\frac{1}{2}$  geo. leagues (226, 845 metres. = 140 miles)

Pirapora to the Cachoeira do Sobradinho - 239 to 240 leagues ready for a steamer - and including the Rio das Velhas a total of 508 leagues can be made transitable with little difficulty.

Below the Sobradinho 29 clear leagues, followed by 44 (rapids) which though dangerous, are transitable to rafts and canoes.

From Vargem Redonda 25 to 26 leagues are unnavigable - including the Great Rapids of Paulo Afonso. Slightly below the line of Rapids 42 leagues, upon which steamers now ply.

The Annuaire du Bureau des Longitudes de France assigns to the São Francisco the 4<sup>th</sup> rank amongst the streams of S. America -

Amazons	5400 Kilometers = 3348 miles
Parana - Plata	3440 " 2133 "
Jocastin	2300 " 1426 "
* São Francisco	2100 * = 1302 Eng. miles

But M. Liás has shown - Some to mouth of Rio das Velhas 800 Kilometers, thence to the sea 2100, making 2900 Kilometers = 1798 English miles!

Cosmic rank 17 or 18.



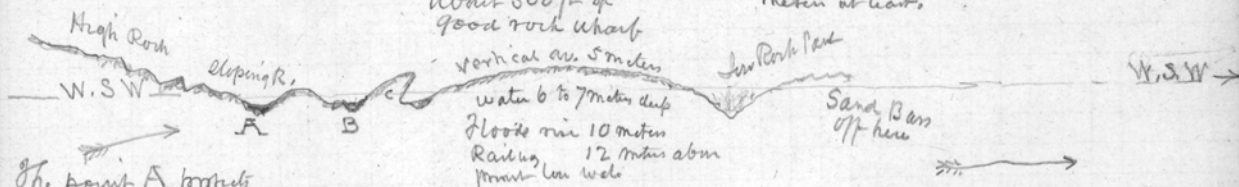
A line could be curved in that would run to near the brow about the middle of the harbor without encountering any rock cutting with mention - from up stream. It could be run in much easier from down stream - and have no rock -

The second ridge 200 ft back (say) from the river bank is rock to the surface.

The low intervals between these ridges shows no rock.

The main ridge just back of the proposed harbor, in the middle and low end, is sand & clayey, composed of at least 2 to 3 vertical depth ahead of rock. On the upper end the rock is at the surface; at the lower end of the harbor there is a deep mass of sandy clayey material 30 or 40 meters at least.

about 300 ft of good rock wharf



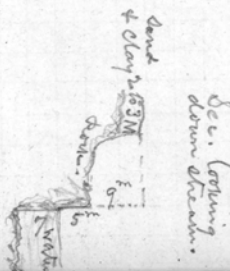
The point A protects the harbor from the current both in low & moderate water.

and so does the point B

c. a little harbor for on boat in low water - good;

and probably will fetch in medium stage; but in high stage, it will lose its character as a little harbor; the current striking across from the point about 1 mile above must impinge against the rock bluff very strongly - the water worn rocks show it.

x 120 ft



For high water an artificial breakwater at the Point B. or in that vicinity, a rip stone on the upper and lower side with caissons in the middle mixed with brush would make a good protection. Exposed out say 30 ft. at top, and sloping at the end 2 to 1 or more - allowing water 7 meters deep in low water - or a crib filled with stone & brush - It will cost about

Manoel do Nascimento Alves Lencarco  
Sec. da Est. de ferro de Paula Affonso  
Piranhas. - direction in Rio. Rua do Jockey Club 26  
S. Francisco Xavier.

Reynaldo von Kzeigel - Eng. em Chefe  
Estrada de ferro da Paula Affonso.

Em Cabrobó - Fortunato Francisco dos Santos  
(rigarista Antonio Jose Ferreira)  
de Novaes.

Antonio Felho de Menezes left behind.

Perena da Andrade - man who went  
to Cotraba after Canons.

Gomez Da Costa is the Ferm. in 7  
mi 12 - guard. 13

Halsfeld's measurement of the Rio São  
Francisco - at Barra Grande on 168 league  
is 176,712 c. palms per second = 1,779 c. meters  
= 62,941 cubic feet per second  
= 3,776,460 cubic feet per minute - On League 168.

661,1000 c. ft. per min  
35.38 166.66 per second

	c. meters
Das velhas	9,159 c. Palm 97.08
S. Franc	22,493 " 238.43
Total	31,652 " 335.51

Calling a palm

0.22 meter, and a C. Palm is 0.0106 c. meter.

677.160  
338.580 (c. ft. per min)  
1015.740 (c. ft. per sec)

Mr. Halsfeld's (Engenheiro) measurement of the flow of  
the San Francisco below the junction of Das Velhas.  
gives - 31,652 cubic palms per second =  $\frac{94,34 \text{ c. palm}}{1 \text{ c. meter}}$   
= 335.51 c. meters = 11,870.34 c. ft. per Sec.  
20,130.60 c. m. = 712,221 c. ft. per Min. This is 1300  
miles above its mouth. <sup>four</sup> times the volume low water  
flow of the Ohio at Pittsburg 967 miles from its mouth.

Total area of new ground  
to be made at Santos - 35,020 m<sup>2</sup>  
Deduct area of the new  
Streets to be paved = 20,427  
Leaves for buildings to 14,593

319 Highest Sum = on 1<sup>st</sup> Seccão.  
21 Piranhas -  
2.88 Difference 297  
3.38 (Proct) x feet 314  
2304 99.34 | 17694 | 178.17  
576  
864  
944.64 fut. above marks

C. meters  
1015.6 per second  
60816.60 per min  
11.2 36  
7.2  
100860  
32 32  
968

Measurement of Rio S. Francisco  
above the Falls.  
Rivir about 2 1/2 palms - 21 inches above  
Sept - 5<sup>th</sup> 1879. extreme low water.  
Cubic m.

Rios	
20.	1 Vintem
100	1 Castão
160	miapateca
200	2 Costões
300	3 "
320	1 Pataca
400	1 Cruzado
480	1 Sello

At Atalho c. meters 1267  
Rivir 758.7 meters - wide = 2488 ft.  
Greater depth 4.25 meters deep 1267 c. m.  
2 channels - the 3.5<sup>m</sup> deep 253.4  
av. vel. 0.729 M. per sec. per sec. 1083.6  
or = 1.63 M. per hour } they agree.

1 cubic palm = Roughly app. 700 x 3<sup>m</sup> per sec = 1470 c. m.  
614.125 c. inch 1267 Cub. m. = 44725 c. ft. per second. =  
1 cubic meter = 2,683,500 c. feet per minute. At the  
35.38 c. feet = present stage of the river - Deducting 15' for  
61,158 c. inches. extreme low water leaves 2,146,800 c. ft. as  
1 c. m. = 94,34 c. P. the low-water flow at Atalho.  
P. Palmos