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The Bado
Ti-V Magnetite Project

BY MINERVA EXPLORATION S.A.

PARAGUAY, 2022

Introduction

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Introduction

The Bado Project located in the Northeast of Paraguay, is in the Prospecting Stage by the company Minerva Exploration S.A., covers an area of 29,900 hectares where the main product consists of Titanium and Vanadium magnetite sands located in a layer of flat laterite 6.5 meters thick, which contains more than 500 million tons of Magnetite Ti-V. Furthermore, the area is invaded by more than 10 diatremes containing Rare Earths, in particular Neodymium and Praseodymium.
The Bado project is a superior resource discovered by renowned american geologist David Lowell.
https://bbc.in/3B82HJ3

The additional basic product would be Bauxite Clay (18.6%), whose reserves are sufficient for the installation of a processing plant to produce Metallic Aluminum.

Financial Technical Summary:

Total area	**29.900 hectares**
Total laterites over basalt	**23.000**
Average thickness laterites	**6.5 meters Specific weight**
Specific weight	**1.64 ton/m3**
Total reserves	**2450 million tons lateries**
Laterites over diatreme swarm	**100 million tons laterites**
Content Ti-V magnetite	**>23% Ti-V magnetite**
Content V205 in laterite	**0.163% V205**
Average Fe in magnetite	**50% Fe**
Average Ti02 in magnetite	**25% Ti02**
Average V205 in magnetite	**0.77% V205**
Reserves Ti-V magnetite (>23%)	**563 million tons**
Reserves Fe (19.5%)	**478 million tons**
Reserves Ti02 (6.22%)	**152 million tons**
Reserves V205 (0.163%)	**4 million tons**
Bauxitic clays	**455 million tons**
Aluminum	**240 million tons**
Quartz sand	**850 million tons**
Neodymium in diatreme laterites	**27 thousand tons**
Praseodymium in diatreme laterites	**8.6 thousand tons**

Licenses granted by the Government of Paraguay

- **Project approval from the Vice Ministry of Mines and Energy of Paraguay by Note N° VMME 493/2021**
- **Approval of the Prospecting Stage from the Vice Ministry of Mines and Energy of Paraguay by Resolution N° VMME 261/2022**
- **Enviromental License from the Ministry of Enviroment and Sustainable Development by Resolution N° DGCCARN 157/2022**

Exploitation Mining Exercise for Capitán Bado

Worldwide, 85% of vanadium is obtained from Ti-V magnetite primary ore, mainly from China, Russia, South Africa and India. The magma, which sourced the Ti-V magnetite in Bushveld, South Africa and the gabbro and basalts from eastern Paraguay and surroundings, were the same source 130 million years ago, when plate tectonics started to separate South America and Africa. These laterite deposits rich in Ti-V magnetite combined with rare earths in Project Capitán Bado in eastern Paraguay are otherwise unique. The prices for the commodities were at their lowest in decades couple years ago, but have been increasing recently and are expected to continue the increase in the next future.

With an extraction similar in size to the Moma Mine in Mozambique moving one hectare of ground per day would produce 7.7 million tons of Ti-V magnetite per year, seven times larger than the largest placer operation for Ti-V magnetite or ilmenite in the world. Mine life would last over 60 years.

Value Ti-V magnetite processed (prices as of April 2021):

0.77% V205 @ $16.700/tn = $ 129/tn

25% Ti02 @ $2.900/tn = $ 725/tn 50% Fe ingot @ $900/tn = $ 450/tn Total = $ 1.300/tn

Magnetite sold bulk: 560 million tons X $ 200 = $112.000.000.000 Sold processed 560 million tons X $1300 = $728.000.000.000 Aluminum: 2 4 0 million tons X $2400 = $571.000.000.000 Quartz: 850 million tons X $30 = $ 25.000.000.000 Nd & Pr 99% pure 8.000 tons X $100.000 = $ 800.000.000

It would be most logical to produce the above as final products on site in Paraguay, considering the location, ease of implementation, judicial security, cheap energy, good infrastructure and the lowest tax regime in America.

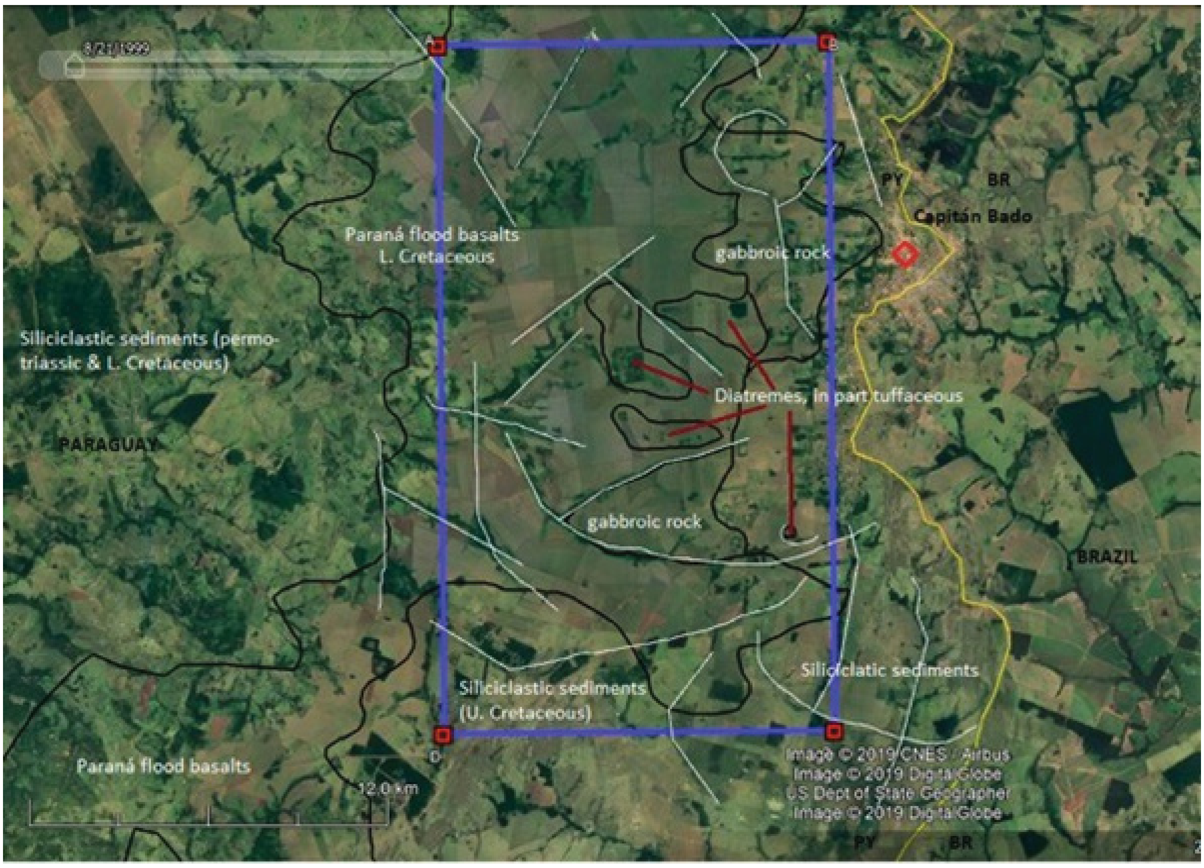
View of abundant Ti-V magnetite on top of road

Location

The Capitan Bado Project is located in NE Paraguay next to the border with Brazil. An open border with Brazil, the village of Capitán Bado in Paraguay and the village of Sapucaia in Brazil divides the immediate town.

There are two secondary roads to Capitán Bado, one from Santa Rosa and another one from Pedro Juán Caballero. Driving takes about 5 hours from Asunción mostly on paved roads.

Vertex	Coordinates 21 K		Area (hectares)
	East	North	
A		7.434.000	29.900
B	647.000	7.434.000	
C	647.000	7.411.000	
D	634.000	7.411.000	



The Project is only 15 minutes from the village Capitán Bado and adjoining town Sapucaya in Brazil. Various farm roads are crossing the Project. The terrain is basically flat; most of it is cultivated for soya, wheat and corn. The swarm of the diatreme complex outcrops in various areas over half of the concession; in view that agricultural equipment cannot work on top of the rock outcrops, forests stay in place. Thus patches of forest in the landscape are diatreme outcrops.

The photos illustrate the almost flat topography where the areas covered with vegetation reflect the outcrops of the diatreme swarm surrounded by laterites covered with agriculture crops, mainly soya, wheat or corn.

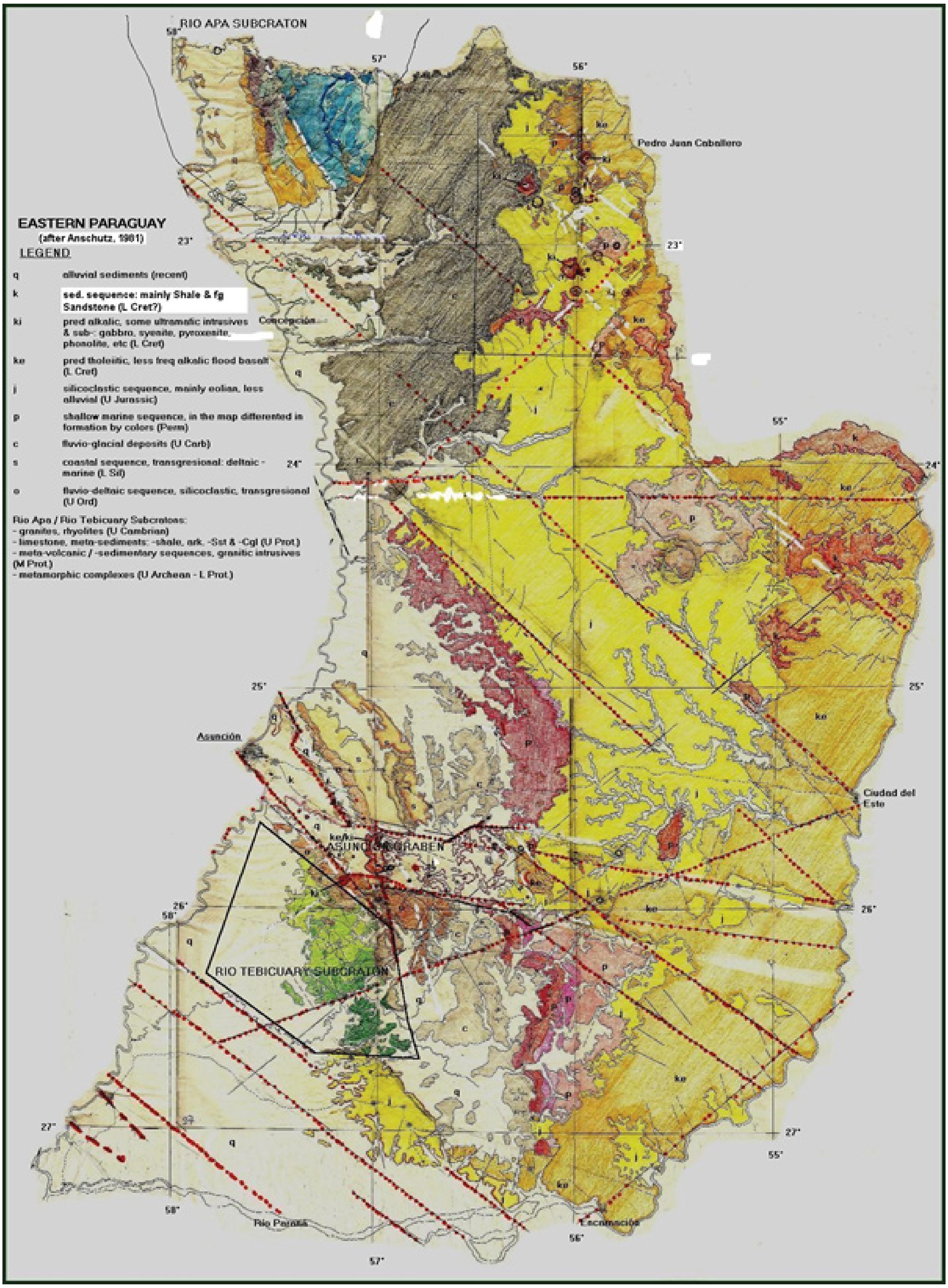
Our Paraguayan company Minerva Exploration S.A. is presided by Rodrigo Díaz with ample experience in civil engineering and our other partner is Wilmar Bartel, geologist with ample experience in the Paraguayan geology, as he had been in charge of several projects with Morrison, Rex Diamonds, Yamana, Newmont, Vane among others. Bartel had noted an areal radiometric anomaly of Anshutz who was exploring for uranium. Bartel scouted the district and noted a large number of diatreme outcrops. He guided Newmont and later Vane to explore for gold, but values were too low to be of interest. In our second scouting we noted the astounding fact that a simple magnet would pick up 100% of all particles of the soil and ground up rocks of the gabro, basalt and diatreme.

After inspecting the black sands on top of the road, it became immediately clear that the particles were octahedral and that all the black sands turned out to be magnetite and not ilmenite. Assays from the black sands in the first trip yielded a high percentage of Ti02 and Vanadium. It become evident that we were looking at a major Ti-V magnetite deposit concentrated in the laterites.

The samples of the third scouting confirmed that the selected area for the Capitan Bado covers at least 23.000 hectares with quite uniform grades of Ti-V coarse grained magnetite.

View of diatreme outcrop and related laterites with high grade Ti-V magnetite and economic gades of Neodymium & Prasedymium

Regional Geology



Map of the geology of Eastern Paraguay.

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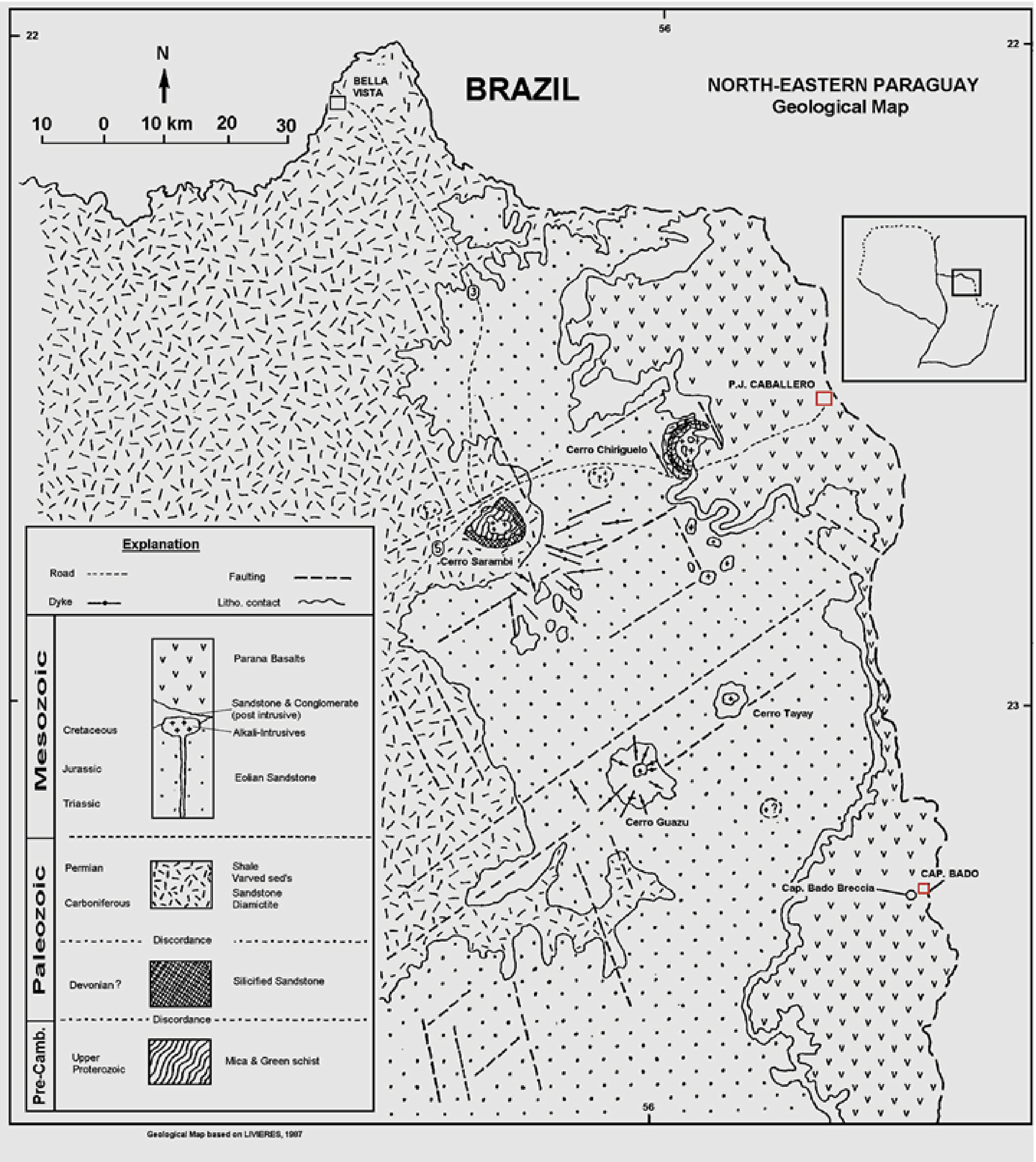
Map of the geology of Eastern Paraguay

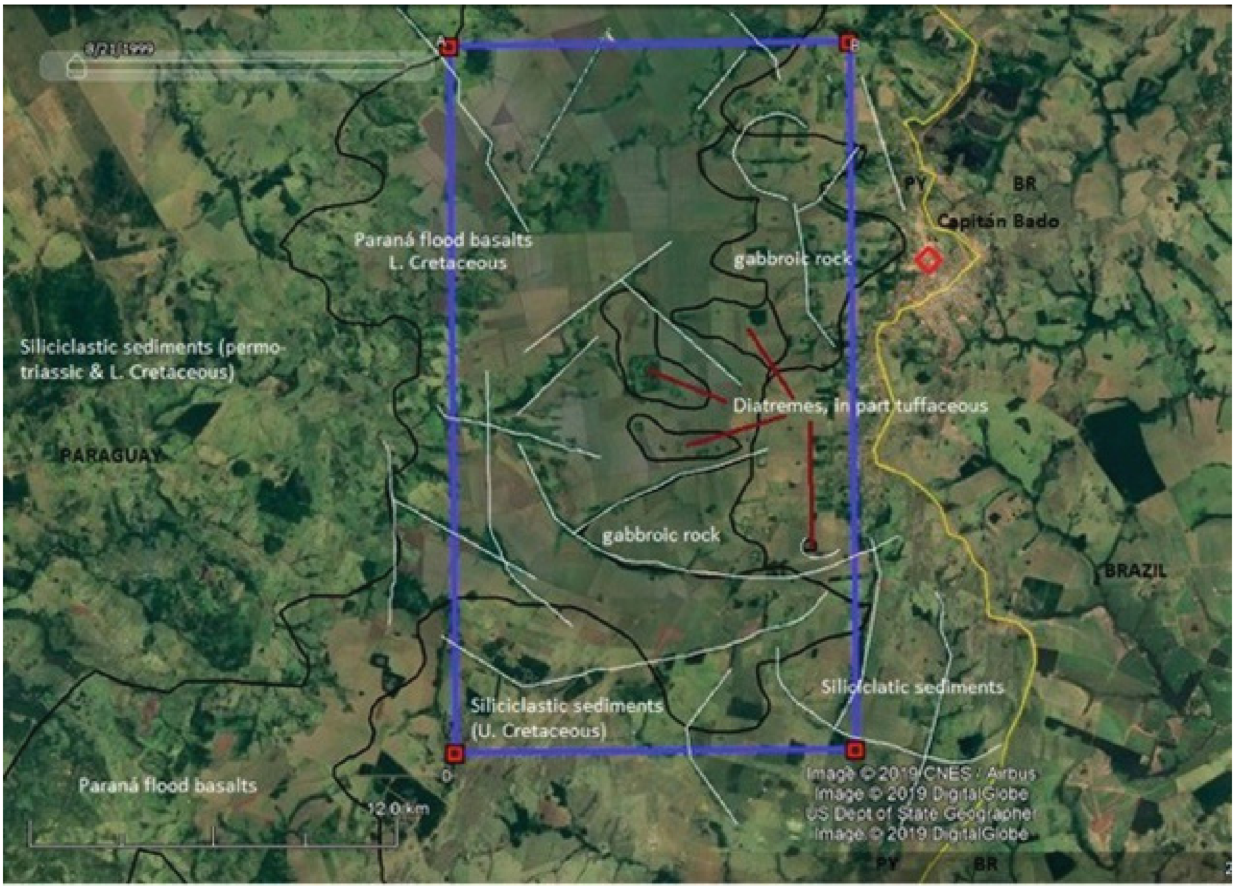


Geologic map of the north-eastern alkaline province.

Local geology

The overall geology in eastern Paraguay with the border of Brazil and to the south with Argentina are early Cretaceous Parana basalt flows from the rift, which started to separate South America from Africa about 130 million years ago. These basalts are covering Permian eolian sandstones. The flows in Brazil may be over 1000 meters thick, while in Paraguay one encounters the initial flows up to two hundred meters thick. The Permian deposits are about 350m above sea level west of Capitan Bado at 550 meters above sea level, while 150km to 200km south the Permian is around 270m above sea level and the basalt border around 400m.a.s.l., but drops to the east to 310m.a.b.s.l.

Between Capitan Bado south end of concession, the Createaceous lacustrine sediments above the basalts outcrop to the south for over 120km to Katueté.

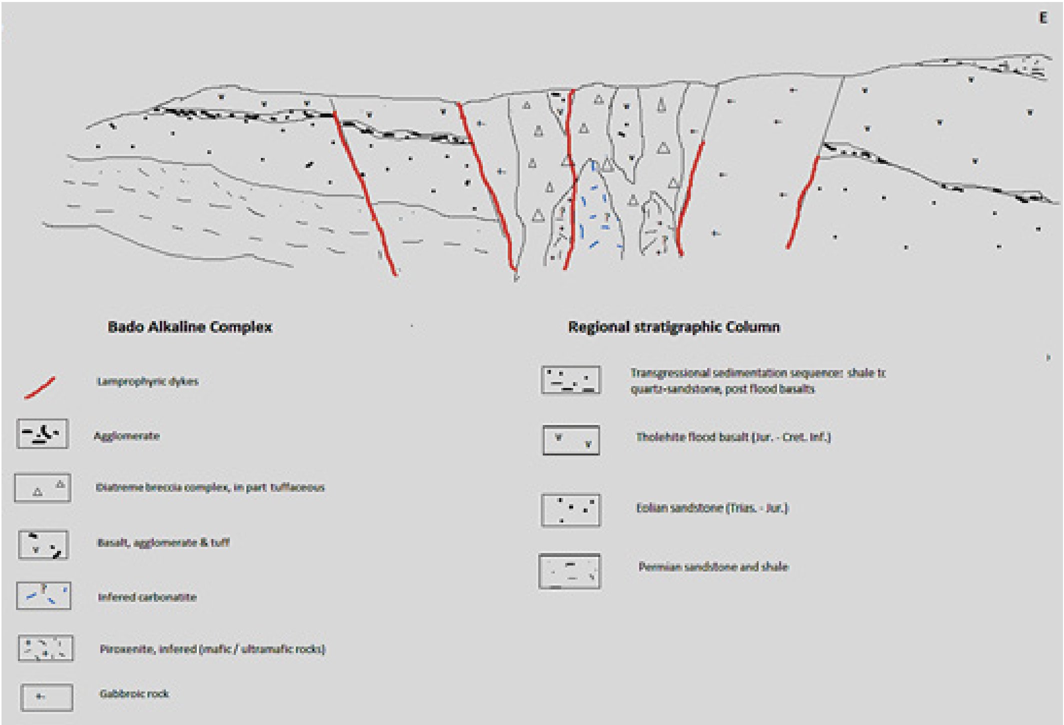


View of geologic map of the Capitán Bado Project.

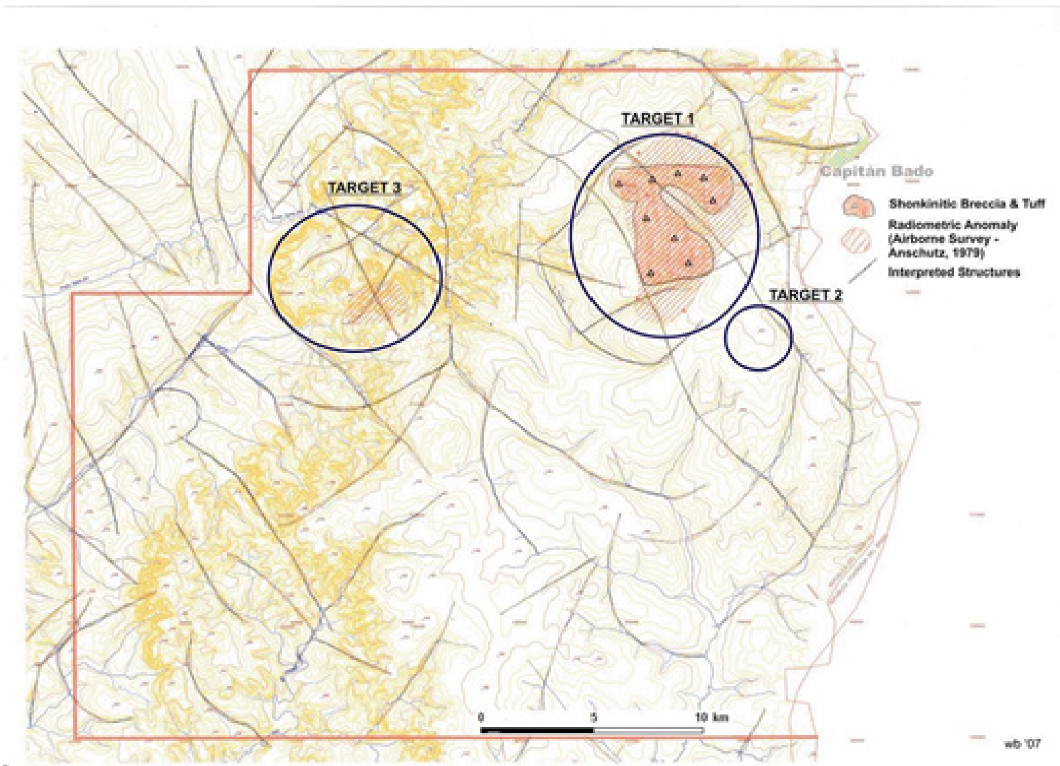
The basalt flows are located about 200m to 300m above the Permian sandstone. The contact is a vertical drop-off between the two.

The basalt outcrops are only seen near the edge of the drop off; different fracturing of the basalts show they are somewhat different to each other. Each flow is often just a few to tens of meters thick. In Capitan Bado basalt outcrops are only seen at bottom of creeks about 10m below the flat agriculture surfaces. The contents will vary in each basalt flow, but the contained value of the Ti-V magnetite will always be economic in relation to the low cost to mine the ore in the laterites.

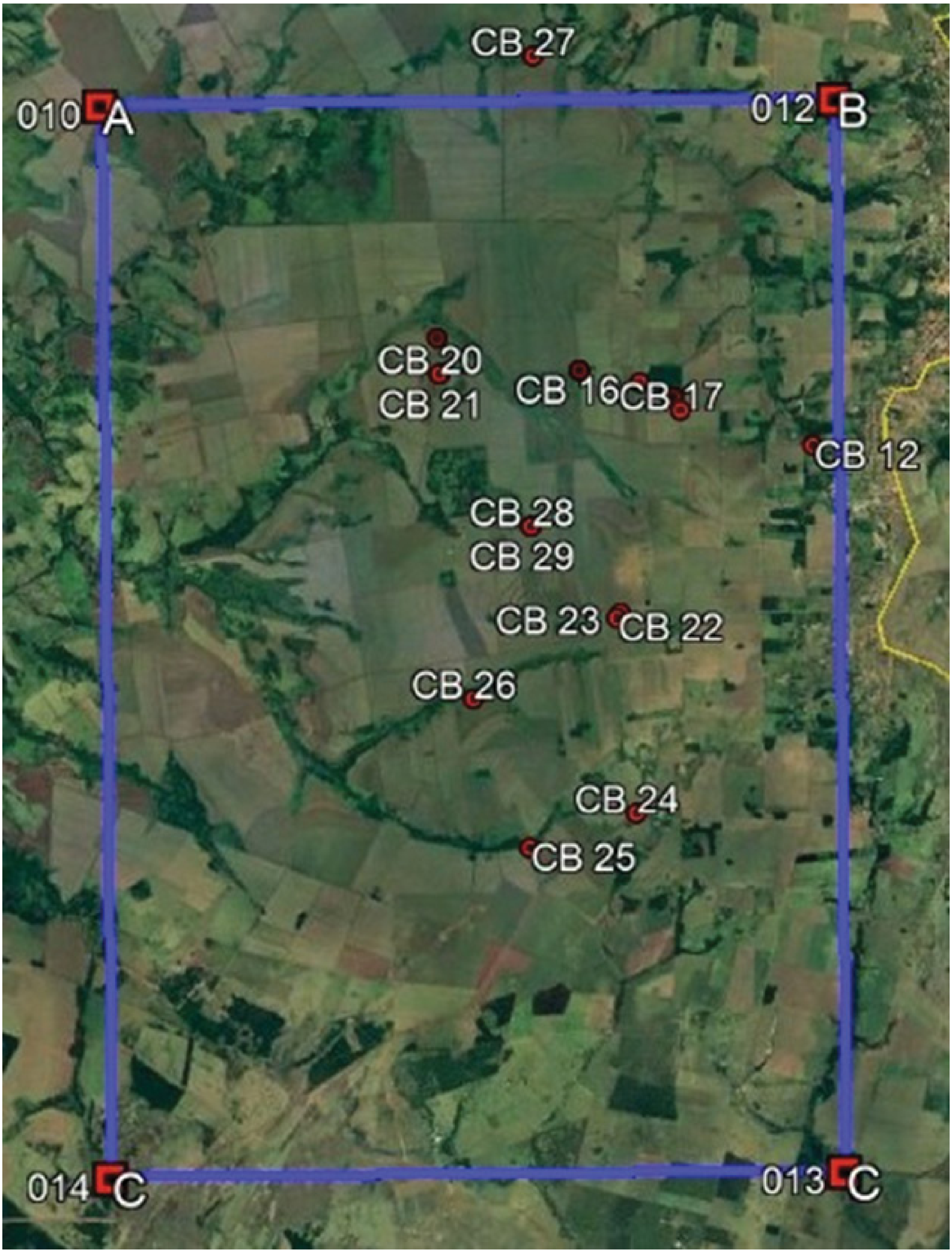
View of different early stage basalt flows which might stack to few hundred meters in Paraguay and over thousand meters in Brazil.



Hypothetical cross-section W-E of the Capitán Bado Project



Structural map of areas of interest at Capitán Bado made in 2001 showing radiometric anomalies related to the diatremes and rare earths.



Map outlining sample locations of the various diatreme outcrops scattered over 100 sq. km

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Bado Laterites

The main mineral commodity at Capitán Bado is the most anomalous high content of Ti-V magnetite in the laterite soils covering 23.000 hectares of the concession.

The laterite in Capitán Bado is a soil rich in iron and aluminum that has formed on top of basalt flows in the hot and wet tropical area over the shield of eastern Paraguay. This soil or laterites is of rusty-red coloration, because of the high iron oxide content. These laterites have developed by intensive and prolonged weathering of sub-aerial leaching and decomposition of the underlying basalt during the last 130 million years. Tropical weathering (laterization) is a prolonged process of chemical weathering, which has produced a quite uniform flat blanket of laterites about 6.5 meters thick covering 23.000 hectares of the of Capitan Bado concession.

The content in unaltered basalt assayed 11.5% Fe, 2.6% Ti02 and 0.083% V205; these commodities have been concentrated in the laterites to 19.5% Fe, 6.22% Ti02 and 0.169% V205.

Commercial mining of laterites consist mainly of bauxite, the main source to produce aluminum and currently lateritic nickel accounts for about 40% of the world nickel production. Typical nickel laterite ore deposits are very large tonnage, low-grade deposits located close to the surface. They are typically in the range of 20 million tonnes and upwards (this being a contained resource of 200,000 tonnes of nickel at 1%) with some examples approaching a billion tonnes of material. Thus, typically, nickel laterite ore deposits contain many billions of dollars of in-situ value of contained metal and are growing to become the most important source of nickel metal for world demand. Nickel laterites are generally mined via open cut mining methods.

Mineralogy

It came as a big surprise when we were scouting for Rare Earths in the swarm of diatremes in Capitan Bado, that the abundant black sands on the roads were magnetite, easy to recognize by the octahedral crystals. To confirm this, we sent two samples for microscope analysis at the Politecnica University in Quito, where they concluded that almost all the sands were magnetite with traces of Goethite, Limonite, very little Ilmenite, Franklinite and Quartz. Sample description of the diatreme swarm is presented in a separate report.

RESULTADOS DE LOS ANÁLISIS MINERALÓGICOS DE LAS MUESTRAS T1-19 Y CB-54

METODOLOGÍA

Se observó que las muestras mayoritariamente estaban compuestas por minerales magnéticos por lo que se procedió a la separación magnética con imán de bolsillo y el separador isodinámico Frantz. Estudio macroscópico con estereomicroscópio (lupa binoculares).

RESULTADOS OBTENIDOS

Minerales Ferromagnéticos

MAGNETITA Fe_3O_4

Cristalografía. Isométrico. Generalmente en forma de cristales de hábito octaédrico, normalmente granular o en grano fino.

Propiedades físicas. H 6. G 5,18. Brillo metálico. Color negro. Raya negra. Fuertemente magnética. Opaco.

Minerales Paramagnéticos

FRANKLINITA $(Zn,Fe,Mn)(Fe,Mn)_2O_4$

Cristalografía. Isométrico. Hábito claramente octaédrico. Los cristales son frecuentemente redondeados.

Propiedades físicas. H 6. G 5,15. Brillo metálico. Color negro. Raya castaño rojizo a castaño oscuro. Ligeramente magnético.

GOETHITA $\alpha FeO.OH$

Cristalografía. Ortorrómbico. Cristales macizos y reniformes. Generalmente sueltos y porosos.

Propiedades físicas. H 5-5,5 G 4,37; puede llegar a 3,3 en materiales impuros. Brillo mate. Color pardo amarillento a pardo oscuro. Raya pardo amarillenta.

LIMONITA $FeO.OH.nH_2O$

Cristalografía. Amorfa. Generalmente suelto y terroso.

Propiedades físicas. H 5-5,5 Brillo mate. Color ocre. Raya parda amarillenta.

ILMENITA $FeTiO_3$

Cristalografía. Hexagonal. Cristales tabulares delgados o en forma de granos.

Propiedades físicas. H 5,5-6 G 4,7. Brillo submetálico. Color negro. Raya negra parda. Débilmente magnética.

Minerales diamagnéticos

CUARZO SiO_2

Cristalografía. Hexagonal. Cristales comúnmente prismáticos, combinación de romboedros que producen el efecto de una bipirámide hexagonal.

Propiedades físicas. H 7. G 2,65. Fractura concoidal. Brillo vítreo. Color blanco a incoloro, pero frecuentemente coloreado por diversas impurezas, pudiendo tomar entonces cualquier color. De transparente a traslúcido.

OBSERVACIONES

Muestra T1-19

Magnetita en gran cantidad en granos finos atrayendo a la limonita y goethita. Franklinita en pequeñas cantidades. Se consigue pocos granos de Ilmenita. Mucho cuarzo euédricos y anedrales, como material ganga.

Muestra CB-54

Magnetita en mucha mayor cantidad en granos euedrales y subedrales, algunos fracturados. Poca cantidad de Goethita y Limonita. Franklinita en pequeñas cantidades y pocos granos de Ilmenita. Mucho cuarzo euédricos, subédricos y anédricos, material ganga.

RECOMENDACIÓN

Para un estudio más detallado se recomienda un estudio con Rayos X. Difractometría.

Analizado por:

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Dpto de Geología. EPN
Enero 2019

c.c. archivo

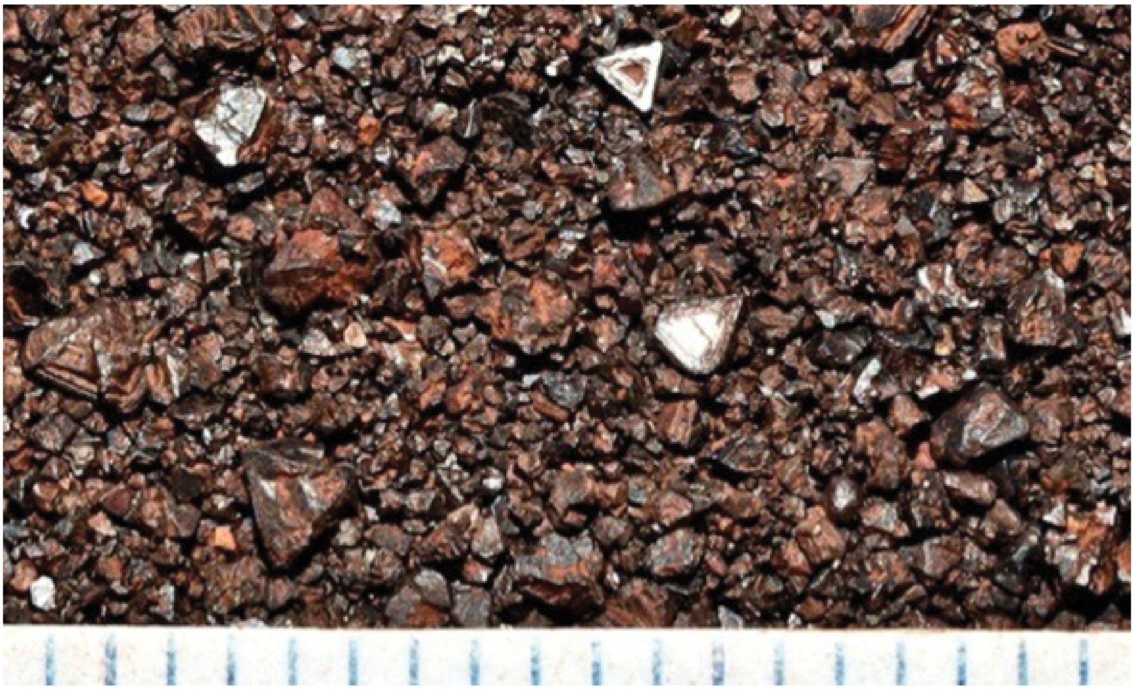
Minerals
in Bado laterites

Ti-V magnetite

The overall average content of the Ti-V magnetite is over 23%; the grades do not vary from the surface down to the basalt. Therefor one would mine all the laterites with no stripping ratio.

Reserves are over 2.45 billion tons of laterite with and estimated content of 23% Ti-V magnetite totalling 560 million tons, with values in the magnetite averaging 50.1% Fe, 25.1% Ti02 and 0.77% V.

Reserves of iron in the magnetite total 280 million tons; pig iron and ingots produced from magnetite is considered of very high quality, particularly if it has very low phosphate values as in Capitán Bado.



Very coarse Ti-V magnetite with octahedral crystals

Titanium

The Ti02 content in the magnetite at Bado averages 25.1%, a very high grade. To compare with the Ti-V magnetite mined in Bushveld-South Africa, it assays in most places around 12% and only in Villa Nora Body 18.6%; in Kurihundi-India it assays 20 to 22.59%, in Kashkanarsky- Russia the concentrate holds only 3.6% and in Gusevogorsky-Russia 2.5%.

The Ti02 may be separated as slag after the magnetite has been melted in a furnace. The quality of the Ti02 is of much higher quality if it is sourced from magnetite, rather than from ilmenite.

The Ti02 reserves in Capitán Bado are over 150 million tons. Considering the low cost of energy, it would be of interest to produce titanium metal by electrolytic methods. Titanium sponge current price is around $20.000/ton and ferro-titanium $18.000 compared to $2380/ton Ti02 and to $200/ton Ti-V magnetite.

It is clear that the big profits are made with final products and the best opportunities to do so are in Paraguay.

Vanadium

The V205 content in the magnetite averages 0.77%. Even in a hard rock mine, 0.77% V205 in the magnetite is a very attractive resource, but in Capitán Bado it is mined open cut in laterites at a very low cost along with the iron and titanium and other sub-products.

The reserves in Capitan Bado are 4 million tons V205. The average content of V205 in the laterite is 0.163% or 1.63kg/ton which is worth @$ 16.7/kg = $25 equivalent to 0.45 gr Au per ton.

Mining one hectare a day, an equivalent volume to the ilmenite open cut Moma mine in Mozambique, would produce over 50.000 ton/year V205; current world production is 150.000 ton/year. It would certainly affect market price and hurt the hard rock mining operations, which operate at much higher costs. Over 85.000 tons are produced in China. 85% of the Vanadium is obtained world wide from the Ti-V magnetite. In Bushveld-South Africa, the Ti-V magnetite assays between 0.4% and 1.6% V2O5. In Gusevogorsky-Russia the concentrate holds 0.59% and in Kachanarsky-Russia 0.60%. In Kurihundi-India it assays between 0.85% and 1.15% V205.

95% pure vanadium cost $20/lb and 99.9% pure is worth about $3 million/ton. Ferro-vanadium steel prices range between $25.000/ton &

$100.000/ton, more examples that refined products should be processed in Paraguay.

Iron

Pig iron and iron ingot would be an initial product in the smelter to obtain the slag, which contains the Ti02 and the V205. Pig iron produced from magnetite and with very low phosphorus content is well sought after in the industry. Currently average pig iron sells for $500/ton and iron ingot at $900/ton.

The reserves in Capitan Bado are 282 million tons in the magnetite and 560 million tons overall in the laterites, certainly enough to justify a smelter in its vicinity, where required infrastructure and power is available.

The pig iron may be converted into FeV, among the most expensive steel on the market or as outlined above into ferro-titanium. There is nearby the required quality of highly pure quartz over 3cm diameter to produce silicon steel. Silicon steel is undoubtedly the most important soft magnetic material in use today. Applications vary in quantities from the few ounces used in small relays or pulse transformers used in generators, motors, and transformers. Paraguay requires huge amount of transformers.

Aluminum

The bauxitic clay is easily separated by washing the laterites. Testing the black sands, 99.9% of the particles are picked up with a magnet.

The bauxitic clays and quartz sands will be settled out in ponds, which represents 18.6% of the laterites.

If one mines one hectare/day equivalent to 100.000/tn/day, which would amount to 19.800 tons of bauxitic clay/day to produce about

10.000 tons of aluminum.

Economics to obtain the bauxitic clays as a by-product certainly warrants to install an aluminum factory in the same location RTZ had planed to build five years ago with a 4 billion investment, where RTZ had planed to import the bauxite from a long distance in Brazil.

The alumina in Bado is in the bauxitic clays, the product of the lateritic leaching process that took place in the basalts. Bauxitic clays have been found, for example, in Brazil and Colombia where Rio Tinto is currently exploring similar clays at "Morales-Cajibió¨.

Samples collected from the bauxitic clays in Capitán Bado have been washed with water and the total alumina grades have been upgraded to values >45% Al2O3 and the total silica has been reduced to values

<20%, generating similar products to those of the "Los Pijiguaos" aluminum mine in Venezuela. While washing the magnetite in the laterites, these bauxitic clays could be exploited as a byproduct to obtain the required cliachite for aluminum.

About 4 years ago, due to low energy costs, RTZ wanted to build an aluminum processing plant in Paraguay, importing the bauxite from Brazil. RTZ wanted to pay $35/megawatt, while the government wanted $45/megawatt. In view that RTZ had large transportation costs for the raw material, this project could be reinstated, considering that

the bauxitic clays would be a cheap by-product located just north of where RTZ wanted to install the processing plant; the plant could be built on site next to the power line. Energy requirements are around 700 MW, equivalent to one of the 20 turbines at the nearby Itapua hydroelectric dam.

Mining one hectare per day (100.000 ton/day laterite), production for aluminum @ $2380/ton x 10.000 tons Al/day = $23'800.000/day

If we consider the aluminum with 9.84% Al/ton @ $2380/ton = $234/ton in the laterite.

Total reserves aluminum are 240.000.000tons X$238= $571.000.000.000 if processed.

Quartz

The reminder of the washed laterites is an average of 32.7% quartz sand. The crystal clear and well-rounded quartz grains over 10 mesh in size might very well apply for fracking in the oil industry, which is required, for example, in Brazil. Using the lowest price for quartz sand around $30 for any industrial uses, would still represent at a daily production mining one hectare per day of 46.000 tons quartz/day @ $30/ton= $1'380.000 per day.

Total reserves of quartz sand is 853.000.000 tons

View of the well-rouned crystalline quartz sand optimal for fracking sand in the oil industry.

Rare Earths

Laterites over the swarm of diatremes contain rare earths, where Neodimium has the most interesting values between 206ppm Nd to >1000ppm Nd in the hard rock.

Examples of diatreme with Neodimium and other rare earths.

Neodymium

is the strongest permanent magnet material yet discovered. It is widely used in microphones, professional loudspeakers, headphones, computer hard disks, electric motors and generators.

Driven by high growth forecasts for electric vehicles (EVs), wind energy and electronics that require substantial volumes of high strength REE permanent magnets, the price of magnetic REEs have moved rapidly upwards in recent months. The price for neodymium (Nd) and praseodymium (Pr), together called "NdPr", has risen almost 50% this year to $65/kg after averaging $41/kg for the last decade. As all major automakers have committed to rolling out new EV and hybrid models, Swiss Investment bank UBS recently forecast NdPr pricing to move to $100/kg by 2025.

Quite a few of our Rare Earths are valued because they are highly magnetic, however Neodynium is the stuff of Superpowers with its ability to permanently carry 1,300 times its weight. Interesting fact the elevators in One Trade Center in New York use Neodynium magnets. In addition to that, Neodynium is also used whenever you need strong magnets in small volume as in smartphones, microphones in other words critical to the ever-growing high tech industry.

Praseodymium

is used in high-intensity permanent magnets, which are essential in electric motors and generators used in hybrid cars and wind turbines. Also used in nickel metal hydride (NiMH) rechargeable batteries for hybrid automobiles. The negative electrode (cathode) in NiMH batteries is a mixture of metal hydrides – typically a rare earth misch metal hydride containing praseodymium, neodymium, lanthanum and cerium.

How many aircraft are in the air right now? How many aircraft need Praseodymium in their engines to deliver peak performance? The answer is every single one. Praseodymium is used in alloys with magnesium to produce high strength metal for aircraft engines. There is also new and surging demand for this metal because it improves UV absorption so a needed component in eye protection, greening crystal glass, ceramic materials. It is widely believed that China will not be able to handle (supply is limited) this increase in demand, which will create new suppliers and thus higher prices because of EU and US sustainable practices in production and supply.

Neodymium Oxide

is a highly insoluble thermally stable neodymium source suitable for glass, optic and ceramic applications. Primary applications include lasers, glass coloring and tinting, and dielectrics.

When neodymium hydroxide or neodymium nitride is burned in air, neodymium oxide is formed. 7,000 metric tons of neodymium oxide are produced globally each year. Oxide compounds are not conductive to electricity. However, certain perovskite structured oxides are electronically conductive finding application in the cathode of solid oxide fuel cells and oxygen generation systems. They are compounds containing at least one oxygen anion and one metallic cation. They are typically insoluble in aqueous solutions (water) and extremely stable making them useful in ceramic structures as simple as producing clay bowls to advanced electronics and in light weight structural components in aerospace and electrochemical applications such as fuel cells in which they exhibit ionic conductivity. Metal oxide compounds are basic anhydrides and can therefore react with acids and with strong reducing agents in redox reactions. Neodymium Oxide is also available in pellets, pieces, sputtering targets, tablets, and nanopowder (from American Elements' nanoscale production facilities). Neodymium Oxide is generally immediately available in most volumes. Additional technical, research and safety (SDS) information is available.

The main methods for producing metallic neodymium are briefly reviewed. These three methods are:

i) electrolysis using fluoride salts,

ii) electrolysis using chloride salts

iii) calciothermic reduction.

Fused salt electrolysis using fluoride remain are the most widely used commercial method for neodymium. An interesting possibility is the reduction of didymium oxide for production of magnets, avoiding the separation between Nd and Pr oxides. A mathematical model able to simulate the reduction is in development. The model takes into account parameters as cell size and geometry, distance between the electrodes and rate of carbon anode consumption.

Rare Earth Oxide Separation

The problem of the commercial rare-earth oxide separation starts in the 1880s when Carl Auer von Welsbach obtained ship ballasts consisting in monazitic black sand from Brazilian shore (coasts of South of Bahia, Espírito Santo and North of Rio de Janeiro States). An essential step in the rare-earth business is the rare-earth oxide separation, because the price of the oxide concentrate without any separation is very low. The separation method depends on the chosen ore. In other words, the flow chart for rare-earth separation has to be

optimized for each specific ore. Rare earths with even atomic number (Z=60 for Nd) are much more abundant that their odd next neighbor (Z=59 for Pr). This is the so-called Oddo-Harkins rule. As consequence, in many ores, Neodymium and Praseodymium appear following the approximate proportion 3 Nd : 1 Pr.

This couple of elements is known as Didymium (from the Greek name for twins), after Mosander studies in the 1840s. Only in 1885 Carl Auer von Welsbach demonstrated that Didymium was in fact Praseodymium and Neodymium. For magnet preparation, it may be better to keep the twins together. As the anisotropy field of praseodymium is higher than that of neodymium, a present day trend is the production of the didymium oxide as a commercial product, avoiding the separation of the didymium twins in the flow-chart. Due to recent renewed interest in rare-earth elements for many different technological applications, there are a number of recent reviews on the rare-earth oxide separation subject. All of them emphasize that the separation process has to adapted or developed for each specific ore.

View of laterites surrounding an outcroping diatreme covered with trees. Sample CB-51 with 18.08% Fe, 5.94% Ti02, 800ppm V (0.143% V205), 22.3% Al203, 29.4% Si02, 137,9ppm Nb, 298ppm La, 604,1ppm Ce, 61,55ppm Pr, 197.5ppm Nd.

Contents in laterites around diatreme outcrops

Laterites diatreme	%Fe	%Ti02	%V205	%Al203	%Si02	ppmNd	ppmPr
CB-33	20.38	6.24	0.131	14.6	35.9	372	117
CB-48	20.86	5.81	0.123	15.2	34.9	219	70
CB-51	18.08	5.94	0.143	22.3	29.4	198	62
CB-52	16.35	5.36	0.101	22.3	33.1	145	58
CB-61	20.63	6.44	0.154	19.2	31.8	368	117
CB-62	17.78	5.69	0.123	23.1	29.7	297	95
CB-63	23.03	6.63	0.182	16.5	30.4	337	109
CB-64	21.27	6.38	0.139	15.3	35.1	280	88
CB-65	21.62	6.41	0.135	15.1	34.2	260	81
CB-66	16.65	4.92	0.142	18.3	37.8	244	77
CB-68	16.23	3.48	0.096	20.7	37.4	244	73
Average	19.35	5.74	0.134	18.4	33.6	269	86

Magnetite diatreme							
CB-32	47.31	10.15	0.289	5.4	11.5	117	37
CB-47	48.71	12.55	0.362	4.1	8.8	82	26
CB-67	40.14	16.49	0.531	6.5	14.5	71	23
Average	45.38	13.06	0.394	5.3	11.6	90	

The average content of NdPr over the 10 diatreme related laterites is 355ppm or 0.355kg/ton. Using the forcast of $100.000 for 99% pure NdPr, this processed commodity would reflect $ 35.5/ton or $58/m3, an equivalent of 1 gram gold in one cubic meter of diatreme laterite

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With the Geiger counter it is easy to establish which laterites are covering a diatreme with a double radioactive count to the laterites over the basalt. Initial scouting suggests an average diameter of 800 meter outcrop of each diatreme and the width of the surrounding laterites of 200 meters. Hence, the volume of the laterite around one diatreme could average around 10 million tons. Considering the ten outcropping diatremes, the potential laterites with rare earths could amount to 100 million tons.

The total reserves of Nd would be 27 thousand tons and Pr with 8.6 thousand tons.

The value of the processed NdPr with 99% metal purity at $100.000 would total $35.600.000.000.

Additional reserves may be mined open pit down to 400m in the diatrem swarm, where the NdPr values are somewhat higher than in the surrounding laterites.

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Sample CB-18 Diatreme with greenish xenoliths and black gabbro;
6490ppm Ba, >500ppm Ce, 10% Fe, 7.44ppm K, 710ppm La, 124ppm Nb,
423ppm Nd, 123ppm Pr.

Sample collection at Bado

In general, the magnetite samples were collected with a hand-held magnet and the laterite samples about 50cm deep using a posthole digger. The XRF unit also gave good and equivalent results for Fe, Ti and V, particularly taking an average of several readings.

Summary Sample Assays Bado

MINERVA EXPLORATION

sample	%Fe	% Ti02	% V205	%Al203	%Si02
Magnetite over basalt					
BADO-03	48.0	24.9	0.452		
CB-27	48.18	24.6	0.706	2.33	2.27
CB-34	46.06	22.8	0.72	4.08	4.64
CB--36	40.56	19.75	0.614	5.74	12.15
CB-39	43.44	22.1	0.77	4.91	7.64
CB-40	34.34	17.50	0.534	5.48	23.9
CB-41	44.37	21.6	0.603	4.14	7.83
CB-45	43.85	21.1	0.620	3.61	9.79
CB-54	46.25	23.6	0.744	3.58	4.5
AVERAGE	43.89	22.0	0.641	3.76	8.1
Magnetite over diatreme					
CB-32	47.3	10.15	0.289	5.42	11.45
CB-47	48-71	12.55	0.362	4.06	8.82
CB-49	43.33	20.1	0.60	4.5	10.65
AVRAGE	46.44	14.26	0.417	4.66	10.3

Ti-V magnetite over basalt		pure recalculated	
BADO-03	50.3	26.1	0.85
CB-27	50.5	26.0	0.74
CB-34	49.9	24.7	0.78
CB-36	49.5	24.1	0.74
CB-39	49.6	25.3	0.88
CB-40	49.1	25.0	0.76
CB-41	50.4	24.5	0.68
CB-45	50.6	24.4	0.73
CB-54	50.3	25.7	0.81
CB-56	49.7	23.9	0.75
average	50.0	25.0	0.77
Magnetite over diatreme pure recalculated			
CB-32	56.9	12.2	0.35
CB-47	56.0	14.4	0.42
CB-49	50.9	23.6	0.71
average	54.6	16.7	0.49

MINERVA
EXPLORATION

laterites	%Fe	%Ti02	%V205	%Al203	%Si02
CB-17	19.04	4.45	0.11	21.0	34.0
CB-26	18.25	6.59	0.164	16.2	38.2
CB-28	16.22	4.8	0.114	18.55	38.7
CB-35	20.63	6.15	0.164	18.8	33.8
CB-37	21.97	8.29	0.22	12.85	38.6
CB-38	17.66	6.31	0.17	18.55	36.8
CB-44	20.29	6.15	0.168	19.3	32.8
CB-46	23.16	8.31	0.243	13.65	34.2
CB-50	20.08	5.23	0.15	19.25	34.2
CB-51	18.08	5.94	0.143	22.3	29.4
CB-52	16.35	5.36	0.101	22.3	33.1
CB-55	22.06	7.13	0.203	18.8	30.2
CB-57	19.82	6.25	0.173	18.15	39.1
Average	19.50	6.22	0.163	18.6	34.8
Laterite over gabro					
CB-31	14.24	2.49	0.077	28.3	35.8
CB-58	11.92	3.65	0.08	12.45	57.7
CB-59	13.74	3.91	0.096	19.25	47.8
Average	13.3	3.35	0.084	20.0	47.1
laterites over diatreme					
CB-33	20.38	6.24	0.23	35.9	14.6
CB-48	20.86	5.8	0.123	15.25	34.9
Average	20.62	6.02	0.177	25.5	32.1

All the soil or laterite over the whole district is 100% magnetic to the last crushed material. The crushed diatreme rocks and related laterites are also 100% magnetic.

Photo showing crushed dry soil or laterite picked up by magnet.

After collecting the black sands on top of the road, one separates the magnetic fraction with the magnet. Only quartz sand is left, with a rare presence of non magnetic black sand particles, less than 0.1%. Tests at the university show that there are some magnetic variations among the Ti-V magnetite.

The main interest is the Ti-V magnetite, an easy commodity to separate by washing the clays.

Sample CB-40 is the heavy fraction of the laterite washed for 5 minutes; we estimate about 1/3 were heavy sands by weight. Once dried, all the material was magnetic assaying 34.34% Fe, 17.50 Ti02 and 0.534% V205, but still contained 5.48% Al203 and 23.9% Si02. These are clays and quartz sand still adhered to the magnetite. Recalculating the magnetite content by discounting the quartz and clay, one obtains 49.1% Fe, 25.0% Ti02 and 0.76% V205, equivalent values to the average of 9 magnetite samples taken from the road.

We consider of main importance the content of Fe, Ti02 and V205 in the magnetic fraction of the laterites over the whole project. Thus we collected 10 magnetite samples on top of the laterites strategically away from each other over the whole concession. The assays were quite similar with an average of 53.89% Fe, 22.0% Ti02 and 0.641% V205. Recalculating the contents in pure magnetite, the averages are 50.0% Fe, 25.0 Ti02 and 0.77% V205.

The next exercise was the possible variability of the content of magnetite from the contact of the laterite with the saprolite and/or hard rock basalt to the surface. The whole district of Capitán Bado is almost flat with small depressions with respective creeks. The only outcrops exposing the laterites are seen in anticlinal road cuts next to the drop-off to the west with the Permian sandstones. At these road cuts we tested with the XRF unit at various points from the surface to the fresh basalt and got similar values for the Fe, Ti and V, concluding that the general average of magnetite is the same over the whole thickness of the laterites.

Laterites only outcrop along road cuts. View of outcrop several meters thick. XRF unit show similar values from top to bottom.

Reserves in Bado Ti-V magnetite Project

The overall area of interest over 23.000 hectares is covered by laterites which were derived from the underlying basalt, diatreme and gabbro rich in Ti-V magnetite, with values in the magnetite over basalts averaging 50% Fe, 25% Ti02 and 0.77% V. The estimate for total reserves are 2'450.000.000 tons of laterite with around 563'000.000 tons Ti-V magnetite, which contain 282.000.000 tons Fe in the magnetite, 152'000.000 tons of Ti02, 4'330.000 tons of V205; one may also consider the aluminum with 240'000.000 tons and the quartz sand with 853'000.000 tons. The Neodymium and Praseodymium would amount to 35.000 tons in laterites over the diatreme swarm.

Collecting black sands accumulated over the laterites

The concession covers an area of 29.900 hectares. About 23.000 hectares are covered by laterites over the basalt, diatreme swarm and gabbro. The remaining 6.900 hectares are quartz sandstones, also intruded by diatremes. The clays in the sandstone formation are also magnetic, but the %Fe is much lower to be considered of economic interest.

Implicit potential reserves: 23.000hectares X 10.000m3/hectare X 6.5m thick = 1500’000.000 cubic meters; with specific gravity 1.64 = 2’450.000.000 tons of laterites.

The laterites over the basalts have an average content of 19.50% Fe or 29.335 Fe205, 6.22% T102, 0.163% V205, 18.6% Al203 and 34.8%

Si02. Other elements add up the remaining 10%. Re-calculating the Fe, Ti02 and V205 average content in the laterites one may estimate a content of at least 23% Ti-V magnetite.

Ti-V magnetite, which contain 282.000.000 tons Fe in the magnetite, 152’000.000 tons of Ti02, 4’330.000 tons of V205; one may also consider the aluminum with 240’000.000 tons and the quartz sand with 853’000.000 tons. The Neodymium and Praseodymium would amount to 35.000 tons in laterites over the diatreme swarm.

Mining laterites

MINERVA EXPLORATION

Mining a laterite is comparable to separate the same desired product from the pulp or milled primary rock, with the difference that the laterite has already a higher concentration of the commodity, because all soluble minerals around it have been washed away over millions of years. By mining a laterite, in the operation one has already saved the initial expense in a hard rock operation, which includes to mine, crush and mill the primary ore!

Mining laterites might be compared with an open pit or long haul mining operation, where the rock type may be considered already as crushed and milled pulp.

One may compare the laterite mining at Capitán Bado with the beach sand operation for ilmenite at the Moma Mine in Mozambique, the largest of its kind in the world (page 45).

One may also compare big advantages to open pit mine laterites with complex placer operations. It is economic to placer-mine gold with 0.2grams Au per cubic meter and 0.6% Au in an open pit hard rock mine, like in Yanacocha-Peru.

Placer mining is a much more complex operation, usually over small restricted areas, where one needs a de-rocker to separate the rocks from the fines to obtain the black sands. The gravels need to be removed with frontend loader. Gravimetric equipment is required to separate the gold from the black sands. To summarize, comparing the Ti-V magnetite in laterites with gold in alluvial, the operation does not require a de-rocker nor sophisticated equipment to separate the gold from the black sands. The contents of the Ti-V magnetite in Capitan Bado is at least 0.230tons @ $200/ton = $46/ton equivalent to 0.9 grams gold per ton or $75 per cubic meter equivalent to 1.4 grams gold. To mine the magnetite and export it in bulk would already prove to be an excellent investment, but if the Ti-V magnetite gets processed in a smelter to produce the outlined commodities, the value of these in the ground would be equivalent to 0.230tons @$1300 = $300/ton equivalent to 5.4 grams gold/ton or 9 grams gold per cubic meter.

If we compare the whole economic content of the laterites with

$300/ton Fe, Ti02, V205 + $234 Al + $10 quartz = $544/ton.

If we add the Neodymium and Praseodymium metal in the laterites over the diatreme swarm value would increase by $50/ton.

Hence, mining the laterites around the diatremes would be $600/ton or

$984/m3, an equivalent of 18 grams gold per cubic meter. Each hectare contains $64 million in finished commodities.

While consulting in 2003 for two years for DuPont to locate titanium ore in Peru, I visited their plant in Gainsville, Florida. The black sands are their main Ti02 source worlwide, where they have a very large floating plant on an artificial lake. Their operation consists in separating all economical commodities, mainly pseudo-leucocine, magnetite, rutile, zircon, garnets, staurolite and quartz sand. The gross sale of all these commodities amounted to $14/ton, where this operation was the most profitable one of all the DuPont enterprises.

Conclusion

Paraguay has deposits of titanium, vanadium, rare earths, iron, bauxitics clays, and quarz in the Bado project, and, due to its low tax regime ease of access to water and availability of cheap energy, the capacity to develop different industries using all these minerals as a raw material.