# A TIPOLOGY PROPOSAL FOR ALEGRIA'S MINES AMPHIBOLITIC ITABIRITES – SAMARCO MINERAÇÃO S.A.[1]

*Júnia Maria de Pinho Rocha*[2]
*Paulo Roberto Gomes Brandão*[3]
*Raul Zanoni Lopes Cançado*[4]

**Abstract**

Since the beginning of its operations, Samarco has been classifying the itabirites in different types of ore based on their physical, chemical, process performance and mineralogical characteristics. The amphibolitic itabirites represents more than 30% of the total Samarco's geological resources and approximately 20% of its reserves. It is still missing a typology for these amphibolitic itabirites, which helps to predict their process performance and to indicate the best way of mining them. The purpose of this study is to investigate two visual different amphibolitic itabirites and based on their chemical and mineralogical characteristics as well as on their performance and results on laboratory tests, verifies if they can be considered as different ore materials types. Thus, two visual distinct amphibolitic itabirites were sampled and submitted to chemical and mineralogical analysis, x-Ray diffratometry, x-Ray fluorescence, grinding, desliming, flotation and Pot Grate furnace laboratory tests. Based on the results it is proposed the subdivision of the samples in two distinct amphibolitic itabirites different types.

**Key words**: Amphibolitic itabirite; Tipology

## UMA PROPOSTA DE TIPOLOGIA PARA ITABIRITOS ANFIBOLÍTICOS DAS MINAS DE ALEGRIA – SAMARCO MENRAÇÃO S.A.

**Resumo**

Desde o início de suas atividades a Samarco vem classificando os itabiritos em diferentes tipos de minérios quanto às suas características físicas, químicas, comportamento nos processos e mineralógicas. Os itabiritos anfibolíticos representam mais de 30% do total dos recursos geológicos da Samarco e cerca de 20% de sua reserva total. Ainda não há uma tipologia proposta para esses itabiritos, que auxilie na previsão de seu comportamento nos processos e que direcione a lavra desses materiais. O objetivo deste trabalho é o de investigar duas amostras de itabiritos anfibolíticos visualmente distintas e a partir de sua caracterização química e mineralógica e de suas características em testes de laboratório, verificar se essas representam tipos distintos de materiais. As amostras foram submetidas a análises químicas, mineralógicas, diratometria de raios-X, fluorescência de raios-X, além de testes de moagem, deslamagem, flotação em bancada e queima em *Pot Grate*. Com base em todos os resultados é proposta a individualização das amostras em dois tipos distintos de itabiritos anfibolíticos.

**Palavras-chave**: Itabirito anfibolítico; Tipologia.

[1] *Technical contribution to the 2nd International Symposium on Iron Ore, September 22 – 26, 2008, São Luís City – Maranhão State – Brazil*
[2] *Geólogo Especiatlista da Samarco Mineração S.A., Doutor*
[3] *Professor Emérito do Depto. Engenharia de Minas da UFMG, PhD*
[4] *Professor do Depto. Engenharia de Minas da UFMG, Doutor*

## 1 INTRODUCTION

The geological interpretation of the Alegria's mines (Samarco) and their typological determination are based on drill holes informations field mapping. Since the beginning of its activities, in 1977, Samarco has been classifying the itabirites in different ore types based on their physical, chemical and process performance characteristics and, since 1992, mineralogical content. A typological-mineralogical modeling has been done since the beginning, and it has been the mine planning and quality control bases.

From 1977 to 1992, Germano mine ores were explored, which were homogeneous itabirites in terms of their chemical, physical and mineralogical characteristics. (ore essentially specularitic).[1] The typology was based on physical, chemical and concentration process tests. Since 1992, the typological itabirite classification started to use mineralogical analysis and, began to classify the types based on their main mineral-ore. Since 1996, an evolution in mineralogical characterization has been done and the different types became to be classified based on their mineralogical associations, were should have exist more than one main mineral.[2]

At the present moment, itabirites from Alegria mines are subdivided in the mineralogical types below; 1) martitic itabirites (martitic hematite >70%); 2) martitic-specularitic itabirites (martitic hematite is more abundant than the specular hematite), specularitic-martitic itabirites (specular hematite is more abundant than the martitic hematite); 3) martitic-goethitic itabirites (martitic hematite is more abundant than the goethite); 4) specularitic-goethitic itabirites (specular hematite and goethite are abundant); 5) martitic-specularitc-goethitic itabirites (the three minerals have almost the same abundance); 6) specularitic itabirites (specularitic hematite is more abundant); 7) amphibolitic itabirites (presence of the goethite pseudomorphous of amphibole); 8) goethitic-martitic itabirites (the goethite is more abundant than the martitic hematite) and, 9) magnetitic itabirites (abundance in magnetite).[1]

The amphibolitic itabirites are characteristics because of their typical colouring that varies from brownish-grayish to brownish-yellowish; the presence of fibrous goethite pseudomorphic of the amphibole (grunerite or riebeckite series); the goethite and the martitic hematite are the main ore minerals; the quartz is the principal mineral gangue; has high contents of P (>0,080%), $Al_2O_3$ (>0,50%) e PPC (>4%) and, has the flotation process as the most indicated concentration method, but for its concentration, it is necessary to make an efficient desliming (% lama >20).[3-4]

These itabirites represent more than 30% from the total geological Samarco's resources and around 20% of its total reserve. They can present perceptible visual differences, like: abundance, size and differences on the arrangement of the amphibole pseudomorphes; rock granulation, various colours and different banding thickness. There isn't an established correlation between amphibolitic itabirites visually different and their respective process performance. By this way, there isn't a typological proposal for these itabirites that can help with their performance in the process and that can direct the mining of theses materials.

The purpose of this study is to investigate two visual different amphibolitic itabirites and based on their mineralogical characteristics as well as on their performance and results on laboratory tests such as desliming, grinding, flotation and Pot Grate, verifies if they can be considered different ore materials types.

## 2 MATERIALS AND METHODS

Firstly, two amphibolitic-tabirites visually distinct that can be individualized and mapped in the scale 1:1000 were identified in Alegria's mines. From each one it had been collected two samples. The first one, of almost 400kg, that after it has been adequately prepared it was taken aliquots for chemical and mineralogical (optical microscopy) analyses, X-ray difratometry, X-ray fluorescence grinding, desliming and flotation laboratory tests. The second samples were of approximately 5t each they were processed in pilot plant to produce concentrates in sufficient quantity for the Pot Grate tests (about 1t).

For chemical composition determination, the samples were analyzed by humid way, for the total Fe and FeO determination and, in the spectrometer of plasma emission (ICP), Spectroflame P Spectro Instruments model to determinate the most important elements. Besides this analysis, it had been determined the samples LOI values.

The X-rays fluorescence spectrometer was used for sweeping spectral trying to detect other elements that can be there. The samples had been analyzed in a Philips PW 2400 sequential X-rays fluorescence spectrometer.

In order to determine the mineralogical composition of both samples, they were analyzed quantitatively (grain counting method) and qualitatively under an optical microscopic, reflected and transmitted light, Leitz/Leica brand, model Laborlux 12POL S.

The samples were also analyzed in a X-rays diffratometer for powder samples, brand Philips, X'Pert-APD system, controller PW 3710/31, creator PW 1830/40 e goniometer PW 3020/00.

The desliming, grinding and flotation laboratory tests were performed by PCM – Processamento e Caracterização Mineral Ltda, a processing company located at Antônio Pereira, Ouro Preto's municipal district. All the tests followed the same standards and procedures used by Samarco's laboratories. The grinding time is that demanded to reduce 90% of the particles to size less than 0,150mm. To determine this time, it was measured the accumulated retained percentage for at least two different grinding times.

The Pot Grate tests were performed in the Samarco's internal laboratory and followed the standards used there (ISO and internal). It was established that the Furnace N.1 temperature profile and a 13.8 million tons of production rhythm should be reproduced.

## 3 RESULTS AND DISCUSSIONS

### 3.1 Chemical Analyses

The chemical analyses results of the two samples are showed in Table 1 and Table 2. From the tables results it can be noted that:

1. For both samples the ROM and underflow $Fe_T$ contents are typical of the poor itabirites and are quite similar. The $Fe_T$ content in the A31 sample concentrate can be considered a low value for a concentrate while for the A91 sample, it can be considered a good result. The $Fe_T$ content for both tailings are within the regular values for an itabirite tailing.
2. The $SiO_2$ content in the concentrate of the A31 sample is higher than the desirable, while for the A91 sample, it is a good result for a bench flotation test.

3. In general, A31 sample presented $Al_2O_3$ tenors very high and actually sufficient to indicate the presence of aluminous minerals. A91 sample presented $Al_2O_3$ values within the usual range for Alegria's itabirites.
4. For both samples, the *P* and the LOI contents are considered high values (above 0,050% and 3%, respectively). For A91 sample, the low values for both variables within the tailing are due to the major presence of quartz (88% of $SiO_2$) than it is in the A31 tailing.
5. The $MnO_2$ and FeO contents are low values and typical of the Alegria's itabirites.

**Table 1** – Chemical analyses results for the amphibolitic itabirite A31 sample.

| Chemical Results | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sample | Aliquot | $Fe_T$ | $SiO_2$ | $Al_2O_3$ | P | LOI | $MnO_2$ | FeO |
| A31 | ROM | 42,00 | 26,10 | 4,53 | 0,127 | 8,99 | 0,04 | 0,28 |
| | Deslimed underflow | 43,13 | 26,72 | 2,97 | 0,117 | 8,34 | 0,04 | 0,68 |
| | Slime | 40,25 | 19,01 | 11,85 | 0,166 | 11,85 | 0,04 | 0,56 |
| | Concentrate | 58,09 | 9,05 | 1,61 | 0,146 | 5,90 | 0,05 | 0,34 |
| | Tailing | 12,35 | 70,46 | 4,95 | 0,049 | 6,80 | 0,02 | 0,36 |

**Table 2** – Chemical analyses results for the amphibolitic itabirite A91 sample

| Chemical Results | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sample | Aliquot | $Fe_T$ | $SiO_2$ | $Al_2O_3$ | P | LOI | $MnO_2$ | FeO |
| A91 | ROM | 44,50 | 32,28 | 0,35 | 0,057 | 3,60 | 0,02 | 0,36 |
| | Deslimed underflow | 43,08 | 35,03 | 0,25 | 0,051 | 2,99 | 0,02 | 0,43 |
| | Slime | 54,47 | 14,27 | 1,07 | 0,100 | 6,54 | 0,02 | 0,29 |
| | Concentrate | 65,17 | 2,14 | 0,29 | 0,067 | 4,28 | 0,02 | 0,38 |
| | Tailing | 7,58 | 88,35 | 0,21 | 0,014 | 0,56 | 0,01 | 0,22 |

### 3.2 X-ray Fluorescence

Tables 3 an 4 show the X-ray fluorescence results for the two amphibolitic itabirites samples. Based on their results, it can be said that:

1. The results for *Fe*, *O*, *Si*, *Al*, *P* and *Mn* elements determined by X-ray fluorescence are in conformity with the chemical results for each aliquot of the same sample. Thus, it was not observed great divergences between the two chemical analyses methods.
2. For both samples (all aliquots), traces of *Cr, Ca, Cl, S* and *Na* were also detected. Traces of *Ti* and *Mg* were detected in the majority of the A31 aliquots (ROM, underflow, slime and concentrate). Traces of *Ti* were detected in the slime of A91 sample and traces of *Mg* in the slime and concentrate of the same sample.

It is well accepted in the literature that in the iron oxides and in the iron oxi-hydroxides, the $Fe^{3+}$ in the octahedral position can be partially substituted by other trivalent metallic cations of similar size, such as $Al^{3+}$, $Mn^{3+}$ and $Cr^{3+}$, without structure modifications (isomorphic substitution). Other cations, e.g. *Ni, Ti, Co, Cu* and *Zn* can be incorporated in the iron oxides/oxi-hydroxides structure [5]. It is also common that goethite presents various quantities of $SiO_2$ and $Al_2O_3$ within its crystalline structure, as well as it can also presents other elements such as *P*, *Ti*, *Mn*, *Cl*, *Mg* and *K*.[(6)] Thus, it becomes quite evident the assumption that the elements found as traces in both samples shall be mainly located within the crystalline structure of their goethites.

**Table 3** – X-ray fluorescence analyses results for the amphibolitic itabirite A31 sample.

| Sample - A31 | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Aliquot*** | **Detected Elements** | | | | | | | | | | | | | | | |
| | **High** | | **Medium** | | **Low** | | | **Traces** | | | | | | | | |
| ***ROM*** | Fe | O | Si | Al | - | - | P | Mn | - | Cr | Ti | Ca | Cl | S | Mg | Na |
| ***Deslimed underflow*** | Fe | O | Si | - | - | Al | - | Mn | P | Cr | Ti | Ca | Cl | S | Mg | Na |
| ***Slime*** | Fe | O | Si | Al | - | - | P | Mn | - | Cr | Ti | Ca | Cl | S | Mg | Na |
| ***Concentrate*** | Fe | O | - | - | Si | Al | P | Mn | - | Cr | Ti | Ca | Cl | S | Mg | Na |
| ***Tailing*** | Si | O | Fe | - | - | Al | - | Mn | P | - | - | Ca | Cl | S | - | Na |

**Table 4** – X-ray fluorescence analyses results for the amphibolitic itabirite A91 sample

| Sample - A91 | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Aliquot*** | **Detected Elements** | | | | | | | | | | | | | | |
| | **High** | | | **Medium** | **Low** | | **Traces** | | | | | | | | |
| ***ROM*** | Fe | O | - | Si | - | - | P | Al | Mn | Cr | - | Ca | Cl | S | Na |
| ***Deslimed underflow*** | Fe | O | Si | - | - | - | P | Al | Mn | Cr | - | Ca | Cl | S | Na |
| ***Slime*** | Fe | O | - | Si | P | Al | - | Mg | Mn | Cr | Ti | Ca | Cl | S | Na |
| ***Concentrate*** | Fe | O | - | - | - | - | P | Al | Mn | Cr | Si | Mg | Cl | S | Na |
| ***Tailing*** | Si | O | - | Fe | - | - | P | Al | Mn | Cr | - | Ca | Cl | S | Na |

## 3.3 X-ray Diffratometry

To illustrate, Figure 1 and Figure 2 show typical X-ray diffratograms for A31 and A91 samples. The total X-ray diffratometry analyses results are disposed in tables V and VI.

For all A31 sample aliquots goethite, quartz, kaolinite, gibbsite and hematite are present among the main minerals. This mineralogy is in a good accordance with the $SiO_2$, $Fe_T$, $Al_2O_3$, LOI tenors determined by the chemical analyses. Thus, the higher $Al_2O_3$ and LOI values are well explained by the presence of the kaolinite and the gibbsite in some abundance. The higher LOI content is also explained by the abundant goethite.

For A91 sample (all aliquots) goethite, hematite and quartz are the main minerals found. Kaolinite is present in low abundance in the slime and as traces in the ROM. As happened with A31 sample, the mineralogy is in a good accordance with $SiO_2$, $Fe_T$, $Al_2O_3$, LOI tenors determined by the chemical analyses.

Once phosphorous and manganese minerals were not found in both samples, it is assumed that these elements are related more to the goethites (present in their crystalline structure), as explained before.

Despite the presence of the FeO (low values) in all aliquots of both samples, no magnetite was found. This can be explained by two facts: 1) the X-ray diffratometer used to analyses these two samples has a copper tube, that elevates the background of iron rich samples and makes more difficult the detection of minerals present in lower concentrations (such as the magnetite). And, 2) materials, such as these itabirites, in which the hematite and goethite are abundant, the magnetite identification becomes difficult due to interferences existing among the main diffraction picks of these tree iron minerals. In this case, the magnetite identification is done by the 2,69Å diffraction pick (30% of intensity) which has no interferences with the other goethite and hematite diffraction picks, but because of its lower intensity, demands more abundance of the mineral, that it is not the case in both samples, in order to it becomes evident.

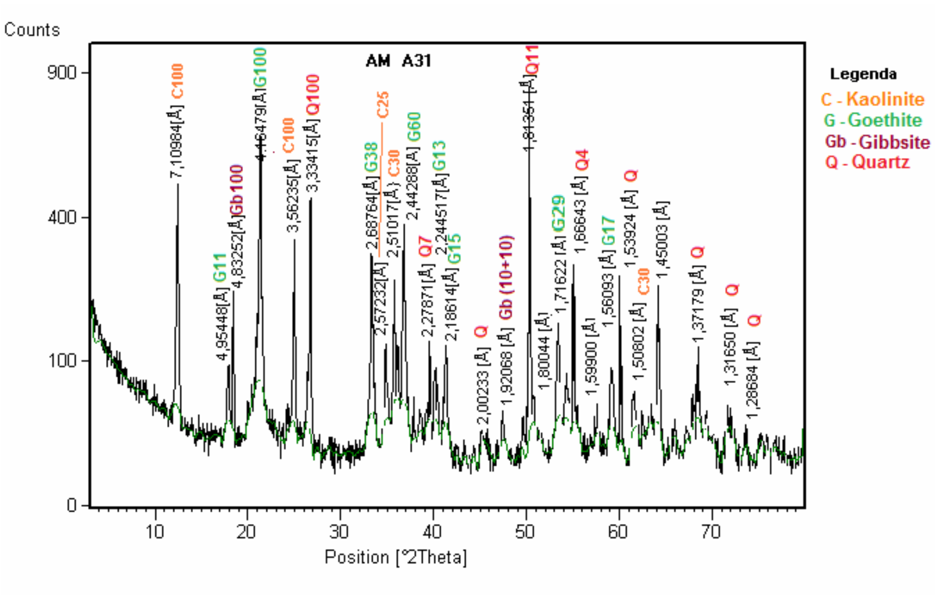


**Figure 1 –** X-ray diffratogram of the A31 sample (ROM).

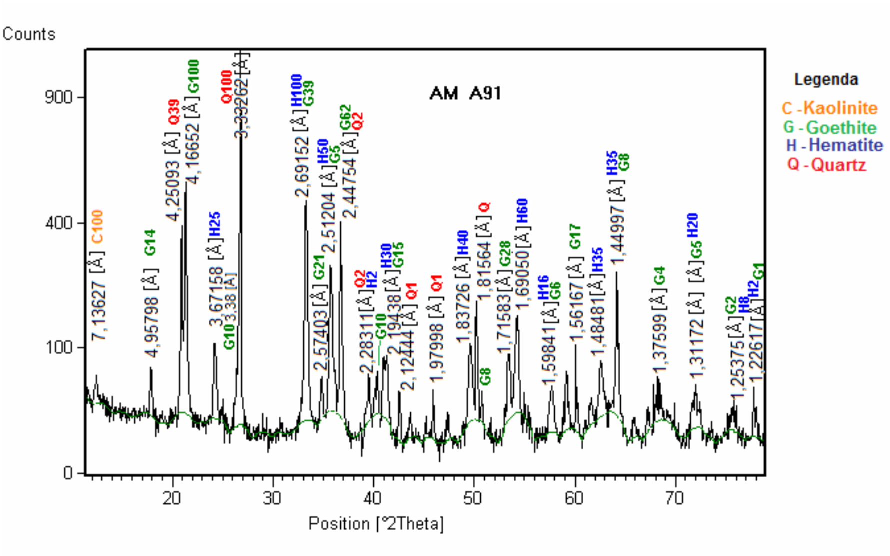


**Figure 2** – X-ray diffratogram of the A91 sample (ROM).

**Table 5** - X-ray diffratometry analyses results for A31 sample

| Sample A31 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Aliquot*** | **Determined Mineralogy** | | | | | | | | | |
| | ***Abundant*** | | | ***Medium*** | | ***Low*** | | | | ***Traces*** |
| ***ROM*** | *Goethite* | *Kaolinite* | *Quartz* | *Gibbsite* | - | - | - | - | - | - |
| ***Deslimed underflow*** | *Goethite* | - | *Quartz* | *Kaolinite* | - | *Hematite* | *Gibbsite* | - | - | - |
| ***Slime*** | *Goethite* | *Kaolinite* | - | *Quartz* | *Gibbsite* | - | - | - | - | - |
| ***Concentrate*** | *Goethite* | - | - | - | - | *Hematite* | *Quartz* | *Kaolinite* | *Gibbsite* | |
| ***Tailing*** | *Quartz* | - | - | - | - | *Goethite* | *Kaolinite* | - | - | *Hematite* |

**Table 6** - X-ray diffratometry analyses results for A91 sample

| Sample - A91 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Aliquot** | **Determined Mineralogy** | | | | | | | | |
| | **Abundant** | | | **Medium** | | **Low** | **Traces** | |
| ROM | Quartz | Goethite | Hematite | - | - | - | Kaolinite | - |
| Deslimed underflow | Quartz | - | - | Goethite | Hematite | - | - | - |
| Slime | Quartz | Goethite | - | Hematite | - | Kaolinite | - | - |
| Concentrate | Goethite | Hematite | - | - | - | - | - | - |
| Tailing | Quartz | - | - | - | - | - | Goethite | Hematite |

## 3.4 Mineralogical Analysis

Table 7 and Table 8 show the underflow, concentrate and tailing mineralogical analyses results for both samples. The grain counting method mineralogical analysis is not applicable when fine and ultra-fine particles are present. So, the ROM and the slime, which have fines and ultra-fines particles, were not analyzed. These mineralogical results reported are by volume.
Comparing the mineralogical results determined by the two different techniques (X-ray diffraction analysis and grain counting method) it is easy to observe that they are in a good accordance one to the other, for both samples.

**Table 7** – mineralogical analyses results for the A31 sample - deslimed underflow, concentrate and tailing aliquots

| A31 Sample | | | | | | |
|---|---|---|---|---|---|---|
| **Aliquot** | **SH (%)** | **MH (%)** | **G (%)** | **M (%)** | **Q (%)** | **K/Gb (%)** |
| **Deslimed underflow** | 0,50 | 8,80 | 55,20 | 0,20 | 33,60 | 1,70 |
| **Concentrate** | 0,20 | 11,80 | 83,10 | 0,20 | 2,40 | 2,30 |
| **Tailing** | 1,10 | 2,40 | 15,00 | 0,10 | 76,60 | 4,80 |

Table 8 – mineralogical analyses results for the A91 sample - deslimed underflow, concentrate and tailing aliquots

| A91 Sample | | | | | |
|---|---|---|---|---|---|
| **Aliquot** | **SH (%)** | **MH (%)** | **G (%)** | **M (%)** | **Q (%)** |
| **Deslimed underflow** | 0,70 | 33,20 | 22,10 | 1,20 | 42,80 |
| **Concentrate** | 1,20 | 50,00 | 42,40 | 2,30 | 4,10 |
| **Tailing** | 0,00 | 4,30 | 4,70 | 0,60 | 90,40 |

The main mineral of A31 sample aliquots is goethite (G) that is present mainly in botryoidal and massive forms and their porosity varying from low to medium. Goethite pseudomorphic of amphibole can be found as well as terrous goethite associated to martitic hematite (ME). The quartz (Q) is usually anedral, occurs mainly in monocrystals, it is preferentially liberated, but some hematite or goethite inclusions can be found. The kaolinite (K) is present as prismatic crystals associated to botryoidal and massive goethite and the gibbsite (Gb) is always terrous. The martitic hematite is not abundant and it is usually porous and very altered. Skeletal martitic hematite can be also found. The specular hematite (SH) is rare and when it is observed, it is forming aggregates or is present as isolated crystals. The magnetite, which is rare, can be found as relicts inside the martitic hematite grain that can be also altered or not, into goethite. In general, the iron minerals alteration grades and their porosity are relatively high. To illustrate, Figures 3 and 4 show two micrographic pictures of the A31 deslimed underflow aliquot.

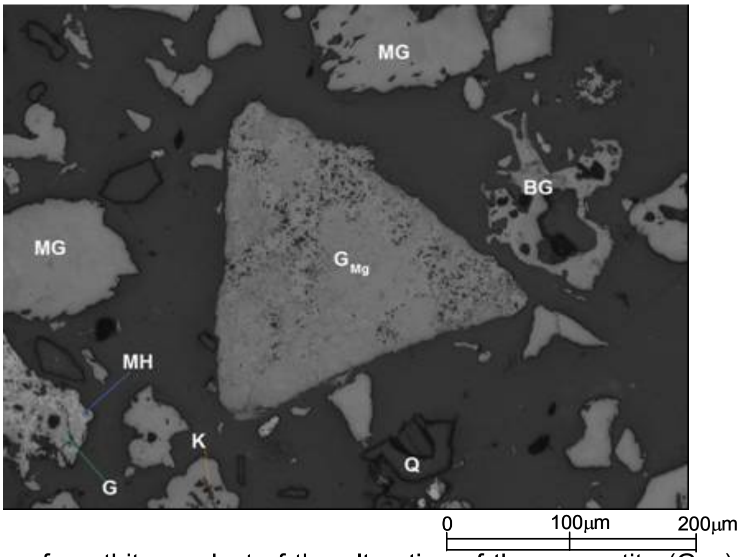


**Figure 3** – Presence of goethite product of the alteration of the magnetite ($G_{MG}$) in the center of the picture. Also: massive goethite (MG), botryoidal goethite (BG), martitic hematite (MH), kaolinite (K) and quartz (Q). 200X. increased. RLND (reflected light not diffracted).

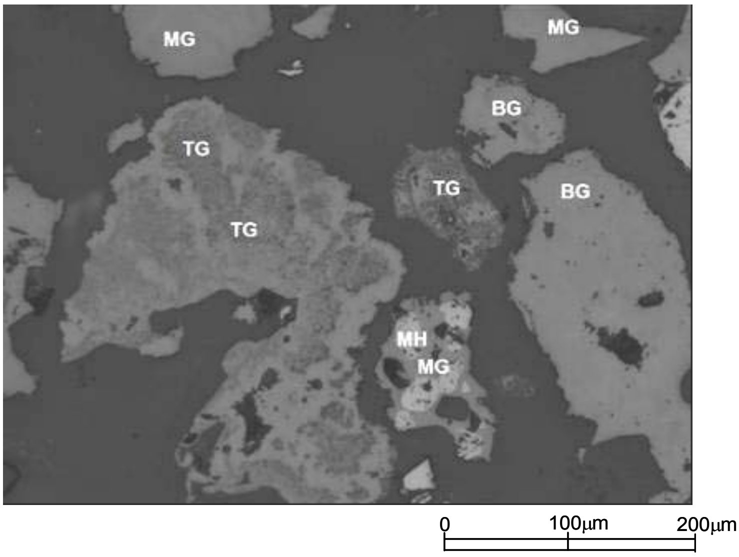


**Figure 4** – It is illustrated terrous goethites (TG), botryoidal goethite (BG), massive goethite (MG) and martitic goethite.(MH). 200X increased. RLND.

In sample A91 martitic hematite is the main iron mineral and it is present in various porosity and alteration grades. The martitic hematite, more porous and also altered into goethite, are the most common. The quartz is the most abundant mineral and as in sample A31, it is usually anedral, occurs mainly in monocrystals, it is preferentially liberated, but some hematite or goethite inclusions can be found. Locally, quartz psudomorphic of amphibole can also be found. Goethite is present especially as pseudomorphs of amphibole, but some massive and botryoidal goethites can be also find. Isolated crystals of specular hematite can be found only locally and the magnetite is present in a low proportion as relicts inside the martitic hematites. In general, the iron minerals alteration grades and their porosity are elevated. To illustrate, Figures 5 and 6 show two micrographic pictures of the A91 deslimed underflow aliquot.

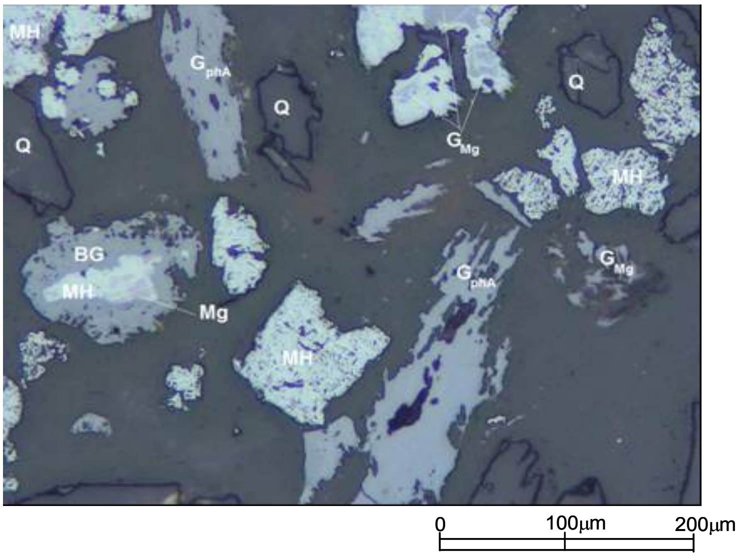


**Figure 5** – It is illustrated goethites: psedomorphic of the amphibole ($G_{phA}$); botryoidal (GB) and product of the alteration of the magnetite ($G_{Mg}$). Martitic hematites (various grades of porosity), quartz (Q) and relict magnetite are present too. 200X increased. RLND.

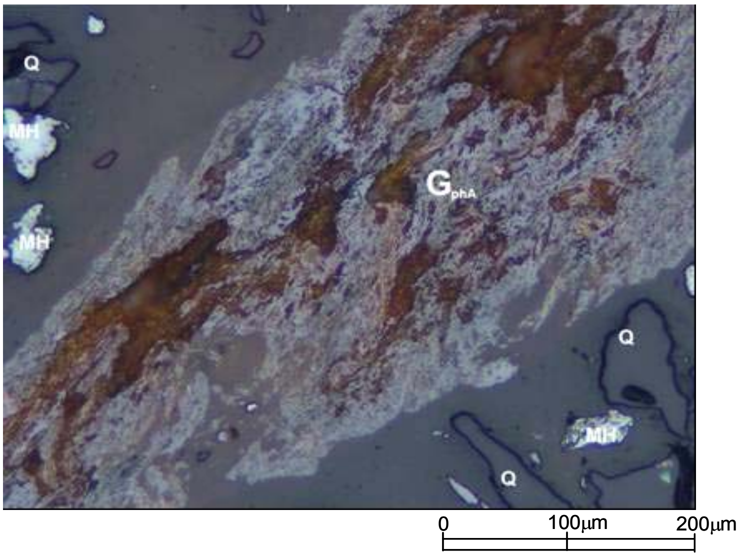


**Figure 6** – It is illustrated in the center part of the picture a big particle of goethite psedomorphic of the amphibole ($G_{phA}$). Quartz (Q) and martitic hematite poor porous are also present. 200X increased. RLND.

### 3.5 Tests – Desliming, Flotation and Pot-grate

Table 9 shows the desliming and flotation batch tests results and the global results for both samples. What can be noted is that;

1. Sample A31 presented a grinding time more than tree times higher than Sample A91. It happens due to the fact that A31 is mostly composed of poor porous and altered massive and botryoidal goethite, more resistant to reduce and so, more difficult to grind. A91, in the other hand, has the porous martitic hematite as the main iron mineral and the goethite pseudomorphic of

amphibole as the principal among the goethites. Both minerals mentioned before are less difficult to reduce compared to the botryoidal and massive goethite.

2. A31 presented slime percentage higher than A91 sample mainly due to the expressive presence of kaolinite and gibbsite in the first sample. In any way, both samples slime percentages can be considered elevated compared to the others Alegria's ores (8% in averageof slimes), because of the presence of the goethite in some expressive abundance.
3. The desliming metallic recovery, flotation weight and flotation metallic recoveries and the global (weight and metallic) recoveries for both samples are quite similar. Except for the desliming metallic recovery, which can not be considered good results for the Alegria's ores (91% in average of DMR in desliming laboratory tests), the other results are considered good and they are actually better than that presented by the Alegria's ores when tested (flotation and desliming) in laboratory.

**Table 9** – Desliming, flotation and global results of A31 and A91 samples.

| ***Sample*** | ***Grinding time (min)*** | ***Slime %*** | ***DMR[1]* (%)*** | ***FWR[2]* (%)*** | ***FMR[3]* (%)*** | ***GWR[4]* (%)*** | ***GMR[5]* (%)*** |
|---|---|---|---|---|---|---|---|
| A31 | 22 | 17,54 | 84,68 | 68,07 | 90,89 | 56,13 | 80,16 |
| A91 | 7 | 10,80 | 86,35 | 62,58 | 93,53 | 55,82 | 78,55 |
| ***Alegria's Ores*** | ***-*** | ***8*** | ***91*** | ***57*** | ***81*** | ***52*** | ***74*** |

*1*Desliming metallic recovery 2*Flotation weight recovery 3*Flotation metallic recovery 4*Global weight recovery 5*Global metallic recovery*

Only the A91 sample completed the Pot Grate test and even though it was not an efficient test, the indurate pellets were able to be evaluated. The strength compression and tumbling of these pellets, which where respectively 104kgf/pellet and 84,5%, they were lower than that of Samarco's specifications (350kgf/pellet and 85% minimum).

## 4 CONCLUSION

Based on the mineralogical results and on the performance of these amphibolitic itabirites in the laboratory tests (desliming, grinding, flotation and Pot Grate), it is proposed a subdivision of these itabirites in two different types:

-Type A1, represented by the A31 sample: because of the presence of the kaolinite and the gibbsite among the main minerals; the major resistance of their particles to reduce due to the predominance of the botryoidal and massive goethite among the iron minerals and the fact that it could not complete satisfactory the Pot Grate test.

- Type A2, represented by the A91 sample that has the martitic hematite and the goethite pseudomorphic of amphibole as the main iron mineral and shows a lower resistance to reduce its particles; this sample was the one that completed the Pot Grate test and even though the results were not satisfactory, it can be an indication of future success if some Pot Grate test parameters would be modified.

## REFERENCES


1 COSTA, A. G. D., ROCHA, J. M. P., BONFIOLI, L., VIEIRA, C. B. A Importância do Modelamento Geológico-Tipológico no Controle de Qualidade dos Concentrados e Pelotas e Minério de Ferro da Samarco Mineração S/A. In: XXIX Seminário de Redução de Minério de Ferro, 24, 1998, Belo Horizonte – MG. p. 545-555.

2 SAMARCO MINERAÇÃO S.A. Geologia e Tipologia dos Minérios da Mina de Alegria. Mariana, 2003 (Relatório Interno).

3 SOUZA JUNIOR, M. *Caracterização Mineralógica e Tecnológica do Minério de Ferro Itabirítico Anfibolítico da Jazida de Alegria*. Belo Horizonte: Escola de Engenharia da UFMG, 1994 200p. Dissertação de Mestrado apresentada ao Curso de Pós-Graduação em Engenharia Metalúrgica e de Minas da UFMG.

4 SOUZA JUNIOR, M. Minério de Ferro Itabirítico Anfibolítico da Mina de Alegria; Caracterização tecnológica. In: I Simpósio Brasileiro de Minério de Ferro: Caracterização, Beneficiamento e Pelotização, 1, 1996, Ouro Preto – MG. p 1-18.

5 SCHWERTMANN, U., TAYLOR, R. M. Iron Oxides. In: _. *Minerals in soil environments*. Dixon, J. B. ed. Wiscosin, 1977. p. 145-180.

6 ROCHA, J. M. P. *Caracterização de Minérios Goethíticos-limoníticos da Mina de Alegria, MG.* Belo Horizonte: Escola de Engenharia da UFMG, 1997. 257p. Dissertação de Mestrado apresentada ao Curso de Pós-Graduação em Engenharia Metalúrgica e de Minas da Universidade Federal de Minas Gerais.