CHEMICAL, PHYSICAL AND TYPOLOGICAL CHARACTERIZATION OF MAIN BRAZILIAN MANGANESE LUMP ORES

G.L. FARIA†, E. L. REIS‡, N. JANNOTTI Jr.§ and F.G.S. ARAÚJO‡

† *Rede Temática em Engenharia de Materiais, Centro, Ouro Preto(MG),CEP 35400-000, Brazil. geraldolfaria@yahoo.com.br*
‡ *Universidade Federal de Ouro Preto, Campus Morro do Cruzeiro, Ouro Preto(MG),CEP 35400-000, Brazil. fgabrielaraujo@uol.com.br*
§ *VALE – Manganês, Nova Lima (MG), CEP 34000-000, Brazil. nelson.jannotti@vale.com*

***Abstract* -- The physical, chemical and typological characteristics of manganese lump ores from three Brazilian mines, Azul, Morro da Mina and Urucum are presented herein. The chemical analysis was done by AES-ICP and titration. The typological characterization was obtained by optical microscopy and X-ray diffraction. The physical properties studied included density, surface area and porosity. The Azul, Urucum and Morro da Mina Mn contents are, respectively, 47.68, 42.69 and 28.44%. The Urucum lump ore presents the highest structural density (4.29g/cm^3), followed by Azul (3.98g/cm^3) and by Morro da Mina (3.56g/cm^3). The Urucum, Morro da Mina and Azul bulk porosities are 22.68, 10.79 and 29.40cm^3/kg, respectively. The oretypological classifications are: anhydrous-oxide for Urucum, hydrated-oxide for Azul and silicate-carbonate for Morro da Mina. The thermogravimetric analysis showed that the ore weight losses could be associated to different phenomena, depending on the ore typology.**

***Keywords* — Manganese, Lump Ores, Brazilian Deposits, Characterization, Typological Classification.**

I. INTRODUCTION

About 98% of all manganese produced in the world is used in ferromanganese alloy production, which is fully consumed by the steel industry. About 30% of the ferromanganese alloys is used for steel de-oxidation and desulphurization, and the remaining 70% for alloying effects. Most manganese found in nature is in the manganese mineral form. Materials containing manganese minerals, together with minerals formed by other elements, are known as manganese ores, which can also be called lump ores (providing their particle sizes are between 50mm and 6.3mm), or fines(if they are below 6.3mm) (Faria, 2008; Tangstad and Olsen, 1995; Olsen *et al.*, 2007).

The manganese lump ores are largely employed as raw material for the production of ferromanganese alloys. The mixtures of these ores, originated from various mines or even different pits of the same mine, are usually defined at the ferroalloy plants solely according to their chemical and granulometric characteristics (Faria, 2008; Tangstad and Olsen, 1995).

A common problem at the operation procedure of metallurgical furnaces in the production of ferromanganese alloys is the lack of knowledge about the mineralogical and physical properties of the manganese lump ores. In this context, important parameters of the lump ores are the mineralogical constitution, porosity distribution and heat decompositions under air continuous flow, which have not been studied adequately yet.

Manganese has great economical significance in Brazil. The three main mines are Urucum, Azul and Morro da Mina (Faria, 2008). The mineralogy of manganese ores is varied and complex. Manganese occurs in more than 300 different minerals, but only a few of those have a significant amount of the element and they make up the ores of higher value. The manganese ores normally exist as oxides, hydroxides, silicates and carbonates (Tangstad and Olsen, 1995; Tangstad *et al.*, 2004).

The Urucum manganese mine is located in the state of Mato Grosso do Sul, in the city of Corumba, near the Brazilian border with Bolivia. The manganese occurs as an oxide. Since the beginning of its exploration, this manganese mine has been one of the most important in Brazil. The terrain is sedimentary with the deposition of primary manganese oxides (Walde *et al*., 1981; Schobbenhaus and Coelho, 1986).

The Morro da Mina mine is located in the city of Conselheiro Lafaiete, in the metallurgical region of the state of Minas Gerais. The rocks from this mine belong to the Rio das Velhas group, identified as a vulcanic-sedimentary sequence in a greenstone belt, included in the Iron Quadrangle (Walde *et al.*, 1981). The main products of Morro da Mina are the carbon-silicates (AMEC, 2006).

The Azul manganese mine is the largest producer of manganese ore (oxide) in Latin America, with an annual production of 2.5 Mt. The ore produced is directed mainly for the production of ferroalloys and, in a smaller scale, to the chemical and batteries industry (AMEC, 2006). The ore is characterized by its high content of hydroxides that justifies considerable weight loss in calcination procedures.

Aiming to improve the knowledge about the chemical, physical and mineralogical characteristics of these three manganese lump ores, this article presents a complete study about the chemical and mineralogical constitution, porosity distribution, and thermogravimetric behavior of them. For each ore, all of these characteristics were compared and typological classifications were proposed. This study is the first step in the beginning of a large investigative study about the intrinsic properties of manganese, aiming to optimize the selection procedures for manganese ore mixtures that compose the