Journal of Mines, Metals and Fuels, 71(12): 2426-2432; 2023. DOI: 10.18311/jmmf/2023/35225

INFORMATICS JOURNALS

Print ISSN : 0022-2755

Journal of Mines, Metals and Fuels

Contents available at: *www.informaticsjournals.com/index.php/jmmf*

A Study of Banded Hematite Quartzite (BHQ) in Mallasamudra Area, Gadag Schist Belt, Karnataka, India

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Abstract

Mineral raw material plays a very important role in the manufacturing industry as well as the country's economic growth. The iron ore, especially the Banded Iron Formations (BIFs) are unique rock formations in geological history. The Mallasamudra area, Gadag Schist Belt (GSB), is having good exposures of iron ores. Most of the outcrops of BHQ are located on the top of the hills whereas metabasalts occur on either side of the hills in the area. The BHQ were delineated during field mapping. In the Banded Hematite Quartzite (BHQ) of Mallasamudra area, SiO_2 varies from 48.22% to 52.12% and Fe_2O_3 varies from 29.23% to 33.21% indicating that the BHQ is of low-grade.

Keywords: *Banded Hematite Quartzite (BHQ), Banded Iron Formation (BIF), Gadag Schist Belt (GSB), Geochemistry, Low-Grade Iron Ore, Mallasamudra*

1.0 Introduction

Raw materials play a crucial role in different sectors as well as in the construction industry. In India, the Dharwar Craton is home to many mineral resources. It supports many mineral resources of the country, including the well-known GSB, Hutti gold mines, Kolar gold fields, Gadag gold fields and iron ore deposits. The entire Dharwar Craton is divided into two blocks, western and eastern, based on the abundance and nature of the age of the gneissic basement rocks and greenstone belts[1]. The evolutionary history and metallogenic characteristics of the western Dharwar Craton and eastern Dharwar Craton are well understood[2]. Further, the Dharwar Craton contains several archaean greenstone belts, including the Hungund-Kushtagi schist belt, Kolar schist belt, Sandur schist belt, Gadag schist belt, Chitradurga schist belt and Dharwar-Shimoga schist belt. The development of the GSB in the 1990s has greatly helped in understanding the geology and gold mineralisation[3]. It is composed dominantly of sedimentaries in the eastern half and metabasalt in the western half[3]. As reported by many researchers, Mallasamudra in the northern part of GSB has good exposures of BHQ and these BHQ are

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associated with gold mineralisation[4]. This warrants their geochemical assessment. Hence, this study concentrates on the geochemical assessment of the BHQ in the Mallasamudra area.

In the Mallasamudra area, we have identified three parallel bands, among them one (Western) is not continuous and the other two (Middle and Eastern) are almost continuous throughout the block. The western band has a strike length of 60m on Binkadakatti Hill and 600m on Asundi Hill. The two others (Middle and Eastern) have a strike length of about 2.5km. The width of these bands varies, ranging from 10m - 20m at some places. All of these bands are folded. Because of this, there is a variation in the orientation of these bands[5]. Some quarrying has been done earlier on all these three bands along the strike, up to a depth of around 5-10m. Also, some grading of the BHQ on the top of the hill has been observed[6].

2.0 Location and Accessibility

The study area of Mallasamudra is a part of the Gadag gold field and it is located near Gadag town, about 6 km south of Gadag city in the taluk and district of the same name in northern Karnataka. The study area is a part of the Survey of India toposheet numbered 48M/11 of 1:50000 scale and is bound by longitudes from 75º 35' 21.15" to 75º 38' 13.20" E and latitudes from 15º 20' 25.14" to 15º 24' 9.65" N. The Gadag district headquarters is situated about 350 km from Bangalore by road towards the northwest of Bangalore city and is also well connected with railway. The Mallasamudra area is well served by all-weather roads, the national highway towards the south-west to Mulugunda Taluk, another national highway towards the west to Hubli-Dharwar city and good tar roads towards Shirhatti taluk (Figure 1).

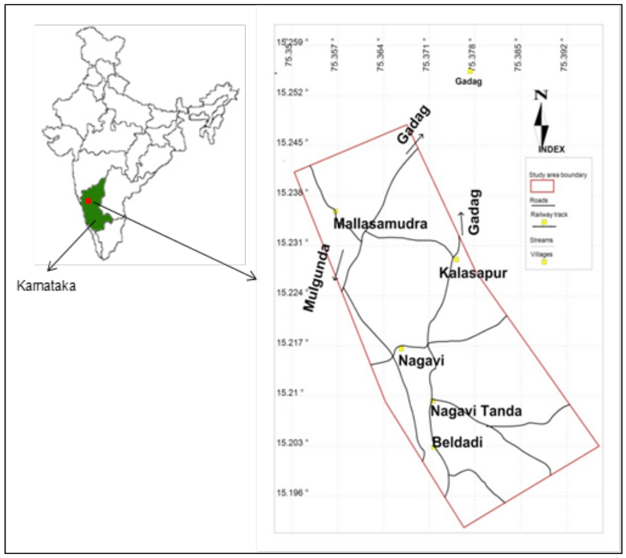

Figure 1. Location map of Mallasamudra area.

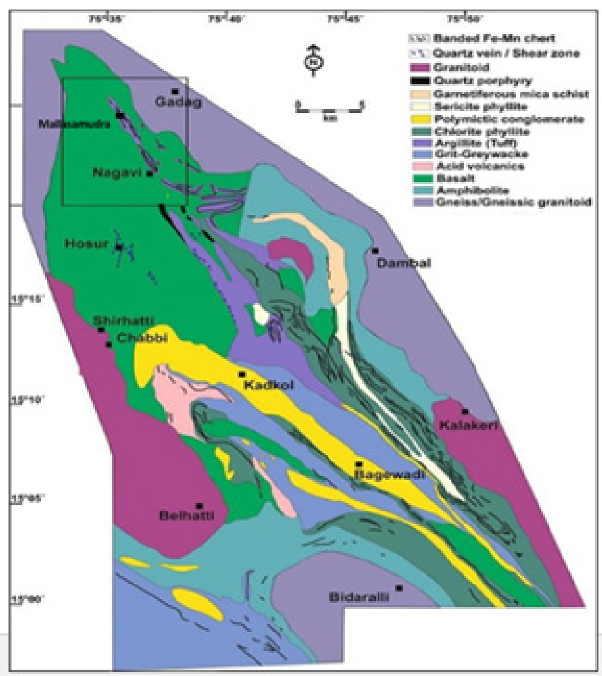

Figure 2. Regional geology of Gadag schist belt (after Ramachandran *et al.* 2001).

3.0 Materials and Methods

Through geological traverses in the area, different lithounits like schist, metabasalt, BHQ, shale, argillite, quartz veins and thin bands of carbonates have been identified. BHQ is located on the top of the hill and occurs as a dissected body occupying the ridge part of the mound. Its exposed thickness varies from 1.2m to 18m. In the Mallasamudra area, BHQ extends up to a length of more than 2.5km in the study area (Figure 2). Floats of BHQ occupy areas surrounding the ridge portion of the mound. These BHQs exhibit prominent banding with alternate layers of fine to medium-grained magnetite/hematite and chert. Hematite and

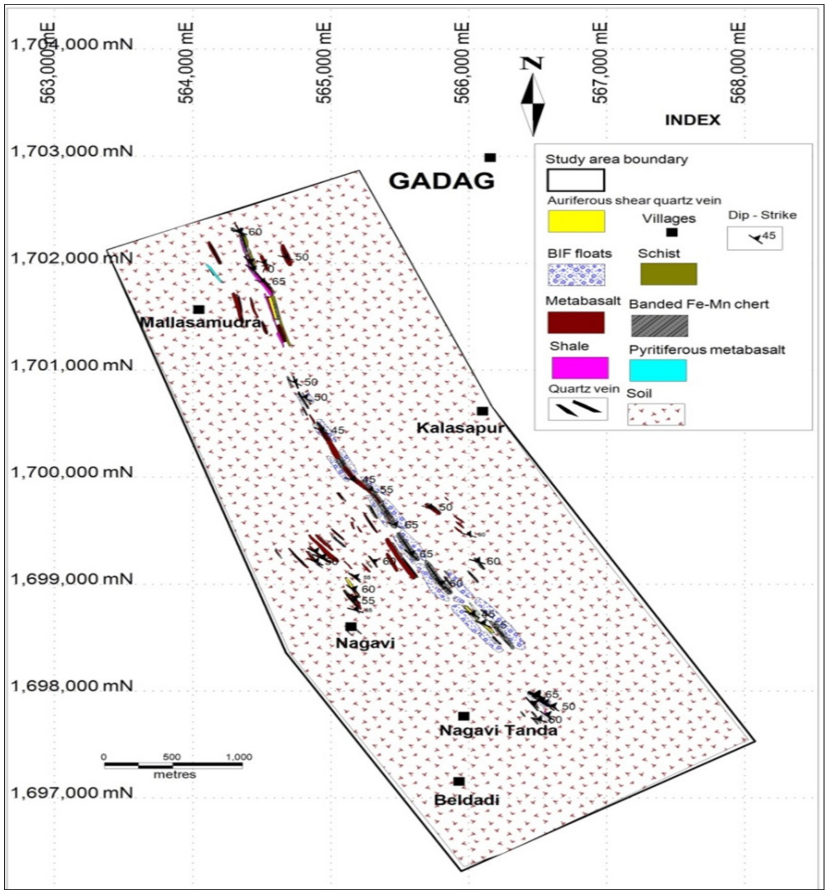

Figure 3. Geological map of Mallasamudra area.

magnetite lead the iron-rich layers, often accompanied by other metal oxides and sulphides such as pyrite and carbonates[7].

Varying amounts of carbonate mineral phases, such as calcite and siderite may or may not be present in both iron-rich and chert-rich layers[8]. In some places, layers of silica may or may not be jasperiferous. In the study area, the thick inter-beds of shale are also associated with the BHQ. Pyritiferous metabasalt occur near Mallasamudra village. Greyish green, medium gained chlorite schist occurs in an old working pit near Mallasamudra village. Schistocity is well developed in these. Metabasalts occur on both sides of the mound and they are cut across by quartz veins at places. These are dark green, medium to fine-grained compact rocks. BHQ occurs as alternating bands within BIFs and quartz veins. Milky white quartz occurs on top of the ridge and thin quartz veins are observed within the BIF bands and metabasalts (Figure 2). Reddish brown-coloured shale with medium to fine grain is observed near Mallasamudra village[9]. Archaean-Proterozoic Dharwar Craton is well-known for its complex course of geological evolution[10]. The schist belts and numerous enclaves of a wide variety of volcano-sedimentary material (2900 Ma) as well as the younger granites (2600 Ma) seen as extensive exposures in the Dharwar Craton lie uncomfortably over the host peninsular gneisses[11] and form the supra-crustal or cover sequences. The importance of the schist belts in the structural evolution of the Craton is well known. The Gadag schist belt consists of a 2000m thick pile of meta-volcanic and meta-sediments[12], and banded iron formation[13]. The auriferous Gadag schist belt is a schist belt of the Dharwar type[14]. At places, quartz veins are intruded into the BIFs and metabasalts (Figure 3).

4.0 Results and Discussion

The BIF samples have been collected from different places in the study area. As a part of the geochemical analysis, various parameters like SiO_2, Fe_2O_3, Al_2O_3, Mgo, Cao, Na_2O and P_2O_5 have been analysed through the XRF analytical instrument. Based on the results of the samples and SiO2, Al_2O_3 and Fe_2O_3 concentration, these samples were grouped as Banded Magnetite Quartzite (BMQ) and Banded Hematite Quartzite (BHQ). The SiO_2 content varies from 48.22% to 52.12%, Fe_2O_3 varies from 29.23% to 33.2% and the CaO content varies from 0.03% to 0.22% justifying the BIF association with carbonates. Also, Al_2O_3 concentration lies between 0.28% and 1.22% and these samples indicate that the BHQ except for sample no. MS1 shows Fe_2O_3 at 33.21% and Al_2O_3 at 1.22%. The MnO content varies from 0.01% to 0.02% which indicates the shaly BIF. These variations indicate the extensive Fe exchange for Mg and other associated minerals with increasing alteration[15].

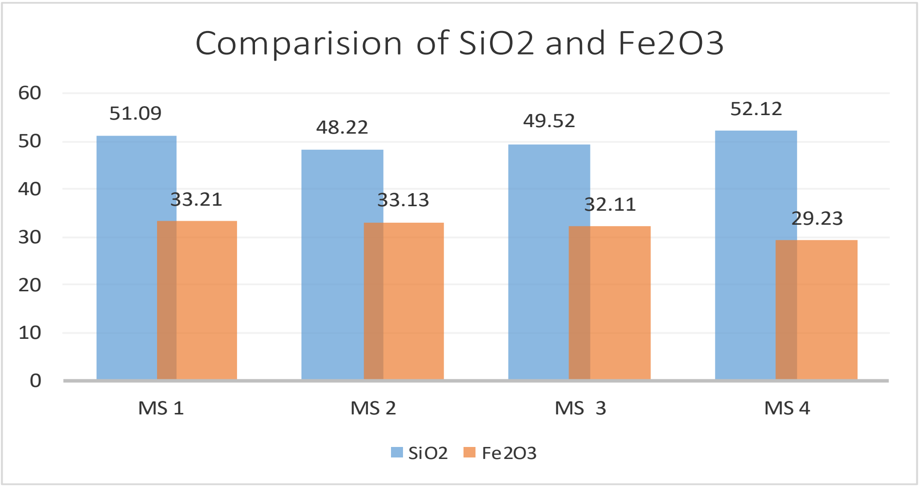

Figure 4. Comparison of SiO_2 and Fe_2O_3 of Mallasamudra area.

Table 1. Average chemical composition of BIF samples from the Mallasamudra area

Parameters / Sample No.	MS 1	MS 2	MS 3	MS 4
SiO_2	51.09	48.22	49.52	52.12
Fe_2O_3	33.21	33.13	32.11	29.23
Al_2O_3	1.22	0.46	0.71	0.28
CaO	0.22	0.07	0.07	0.03
MgO	0.31	0.13	0.13	0.03
MnO	0.02	0.01	0.01	0.01
Na_2O	0.14	0.05	0.25	0.23
K_2O	0.05	0.03	0.06	0.04
P_2O_5	0.04	0.18	0.09	0.06

Figure 5. Metabasalt associated with BHQ bands and quartz veins.

Figure 7. BHQ associated with Quartz intrusion and metabasalts.

Figure 6. Quartz vein in Banded Iron Formation (BIF) on top of the hill.

Figure 8. Quarrying of low-grade iron ore in the Mallasamudra area.

The correlation of Al_2O_3, CaO and alkalies suggests little input of feldspar in the BIF. The K_2O content in these varies depending on the degree of oxidation, ranging from about 0.03% to 0.06%. The distribution of aluminium fluctuates little with regard to alteration and the depletion in samples that have been chloritised and silicified-hematised is likely a reflection of the absence of alumina silicates. It varies from 0.28% to 1.28% (Table 1). It is known that the geochemical characteristics of modern-day volcanic rocks from a particular tectonic setting are consistent and are reflected in the behaviour of certain groups of elements.

Based on the content of Fe_2O_3 this BHQ can be considered as low-grade iron (Figure 4). These low-grade iron ores might play a crucial role in meeting the country's need as the high-grade ones are fast depleting. This research will help contribute to the country's mineral resources.

There are numerous small barren quartz veins and these have the same strike. A few of these cut across the metabasalt at various angles in different places. Metabasalts are usually small and consist of disconnected lenticular patches of quartz on either side of the hill (Figure 5 to Figure 8). Fractured and sheared quartz veins come in contact with BIF's outcrop at the top of the hill. The vesicular textures are extrusive rocks containing voids left by gas bubbles that escape as lava solidifies.

5.0 Conclusions

The SiO_2 content in these iron formations varies from 48.22% to 52.12% and Fe_2O_3 content varies from 29.23% to 33.21%, and the CaO percentage varies from 0.03% to 0.22% justifying the BIF association with carbonates. Al_2O_3 lies between 0.28% to 1.22%.

The geochemical results showing the iron content (Fe_2O_3) in BHQ varies from 29.23% to 33.21% which indicates that these are low-grade iron ores. BHQ with other formations that indicate banding between micro and meso bands of iron oxide and silica reveal that they are of sedimentary origin.

6.0 Acknowledgements

The authors are thankful to Dr. M. Basavanna, Professor (Retired), Karnataka University, Dharwad, India for providing continuous support for this paper. The authors are also thankful to Mr. Mahesh M. Karekoppa, Senior Geologist, Geological Survey of India, Southern Region, Bangalore, for valuable suggestions. The authors express gratitude to Dr. A. Sreenivasa, Professor and Chairman, Department of Studies in Geology, Karnataka University, Dharwad, for his continuous support in completing this paper.

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