Petrographic Characteristics of The Jogipatti Carbonatites of the Samalpatti Complex, Tamil Nadu, Southern India

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Abstract- Carbonatites are unusual igneous rocks that are primarily composed of carbonate minerals, such as calcite, dolomite, and siderite, rather than silicates like most other igneous rocks. Calcio-carbonatites with calcite as main component that is subdivided into coarse-grained sövite and medium to fine-grained alvikite. Magnesio-carbonatites, also called beforsite and are mainly composed of dolomite. Ferro- and natro-carbonatites are either iron-rich or are composed of sodium or potassium carbonates. The geological setting of the Samalpatti carbonatites, which are associated with the Koratti fault system. The Jogipatti area of the Samalpatti Complex, which belongs to the Southern Indian Granulite Terrain. Geologically, the Samalpatti Complex is classified as Neo-Proterozoic in age. Most of the carbonatite rock bodies occur in drilled wells, small lensed bodies, and outcrops. Carbonatite exposures are limited. dolomite emerges as the dominant mineral, enveloped by iron oxide material. Calcite mineral is distinctly surrounded by iron-rich material.

Index Terms- Carbonatite, Dolomite, Jogipatti, Samalpatti, SGT.

I. INTRODUCTION

Carbonatites are unusual igneous rocks that are primarily composed of carbonate minerals, such as calcite, dolomite, and siderite, rather than silicates like most other igneous rocks. They are relatively rare, making up less than 1% of the Earth's continental crust, and are often associated with alkaline igneous complexes (Woolley & Kempe, 1989; Le Maître et al., 1989). These rocks typically form in intrusions associated with continental rifts or hotspots, where unusual conditions such as high concentrations of carbon dioxide and water in the magma exist. Carbonatite magmas are usually less viscous than silicate magmas, allowing them to flow more easily. The minerals found in carbonatites can include rare-earth elements, niobium, tantalum, phosphorus, and uranium, making them economically significant for mining. Many carbonatite deposits are associated with valuable mineral resources, and they are often sought after for their potential economic importance. Intrusive or extrusive igneous rocks with more than 50 Vol.% calcite and less than 20 wt. % SiO_2 are classified after Streckeisen (1980) and Maitre et al. (2005) as carbonatites. If the SiO_2 content is higher, the rock is classified as siliciocarbonatite. The CaO, MgO and FeO classification diagram (Woolley & Kempe, 1989) of the three main types of carbonatite rock types is shown in Fig.4. Following classes of carbonatites can be distinguished (Fig.4, Table.1), calcio-carbonatites with calcite as main component that is subdivided into coarse-grained sövite and medium to fine-grained alvikite. Magnesio-carbonatites, also called beforsite and are mainly composed of dolomite. Ferro- and natro-carbonatites are either iron-rich or are composed of sodium or potassium carbonates. Table.1 summarizes the nomenclature for carbonatites and the chemical characteristics. A process-related carbonatite classification into two groups was implemented by Mitchell (2005), primary igneous carbonatites and carbothermal residua. The primary igneous carbonatites are associated with different magmatic rocks like kimberlite, nephelinite, melilitite and other mantle-derived silicate magmas. Low temperature CO_2, H_2O and fluorine rich fluids form the carbothermal residua.

II. GEOLOGICAL SETTING

The geological setting of the Samalpatti carbonatites, which are associated with the Koratti fault system (Srivastava and Hall, 1995). These faults trend northeast-southwest and terminate at the charnockite mobile belt. The radiometric dating results mentioned indicate that the Samalpatti carbonatites have an age of approximately 700±30 million years (Ma) based on the Potassium-Argon (K-Ar) method (Moralev et al.,

1975). Additionally, the adjacent Sevattur carbonatite complex has been dated to approximately 771±18 Ma using the Rubidium-Strontium (Rb-Sr) whole-rock dating method. These age determinations provide important insights into the timing of carbonatite formation and the geological history of the region. The study area, located in the northern part of Tamil Nadu state, specifically in the Uthangarai Taluka of the Krishnagiri district, encompasses the Jogipatti area of the Samalpatti Complex, which belongs to the Southern Indian Granulite Terrain (SGT). Geologically, the Samalpatti Complex is classified as Neo-Proterozoic in age and is primarily composed of Syenite, Carbonatite, and Pyroxenite rock types (Udas and Krishnamurthy, 1970). Most of the carbonatite rock bodies occur in drilled wells, small lensed bodies, and outcrops. Carbonatite exposures are limited, with some found as boulders and mounds in agricultural fields and residual landforms. The Jogipatti carbonatite exposures are mainly associated with syenites.

III. PETROGRAPHY:

Based on Woolley's (1982) chemical classification, carbonatites can be divided into three groups. Calciocarbonatites: These carbonatites are predominantly composed of calcium carbonate ($CaCO_3$) minerals, such as calcite. They typically contain high concentrations of calcium and relatively low amounts of magnesium and iron. Magnesiocarbonatites: Magnesiocarbonatites are characterized by a high proportion of magnesium carbonate ($MgCO_3$) minerals, such as magnesite. They have elevated levels of magnesium and may also contain significant amounts of calcium carbonate. Ferrocarbonatites: Ferrocarbonatites are rich in iron carbonate ($FeCO_3$) minerals, such as siderite. They have high iron content and may also contain variable amounts of calcium and magnesium carbonates. Mineralogical Composition In addition to dolomite (Fig. 2B), the Jogipatti carbonatites may contain other minerals commonly associated with carbonatite complexes. These could include calcite, magnetite, apatite, phlogopite, and various accessory minerals depending on the specific geochemical conditions during formation. Textural Characteristics: The equigranular and fine-grained texture of the carbonatites suggests relatively uniform grain size distribution and fine crystal sizes, indicative of rapid cooling or crystallization from magma. The allotriomorphic nature of the grains suggests that they lack well-defined crystal shapes, likely due to the rapid cooling or partial recrystallization of the magma. Understanding the geological context of the Jogipatti carbonatites within the broader Samalpatti Complex and the Southern Indian Granulite Terrain can provide insights into their origin, tectonic setting, and relationship to regional geological processes such as magmatism, metamorphism, and tectonic events. In micro photograph, the rocks are characterized by medium to coarse-grained and exhibit in-equigranular texture. In Fig. 3A and 3B, dolomite emerges as the dominant mineral, enveloped by iron oxide material. This observation suggests a significant presence of dolomitic carbonate minerals within the carbonatite samples, with iron oxides likely occurring as associated phases or interstitial material. Calcite mineral is distinctly surrounded by iron-rich material. This observation suggests a notable presence of calcitic carbonate minerals within the carbonatite samples, with iron-rich phases occurring in close association or as a surrounding matrix (Fig. 3.1 D&E).

IV. ANALYTICAL TECHNIQUES

The Jogipatti carbonatites were prepared as thin sections with a thickness of up to 0.03mm to facilitate microscopic examination of their petrographic features. These thin sections were analyzed using a LEICA DM750P model petrological microscope in the microscope lab at the Department of Geology, Osmania University, Hyderabad. This analytical approach allowed for detailed investigation and characterization of the mineralogical and textural properties of the carbonatite samples.

V. ACKNOWLEDGMENTS

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VI. CONCLUSION

Petrological studies on the Jogipatti carbonatites of Samalpatti Complex are suggested the following conclusive remarks. The carbonatite is made of medium to coarse grained, euhedral to sub-euhedral grains of dolomite and calcite grains. A calcite grain shows clearly cleavage. Jogipatti carbonatites are abundantly presence of calcite, dolomite and Fe-rich oxides. Calcite and dolomite minerals are clearly showing surrounded by Fe-rich oxides. Based on the petrological characteristic features of Jogipatti carbonatites are Ferro and Magnesio-rich carbonatites.

VII. LIST OF FIGURES

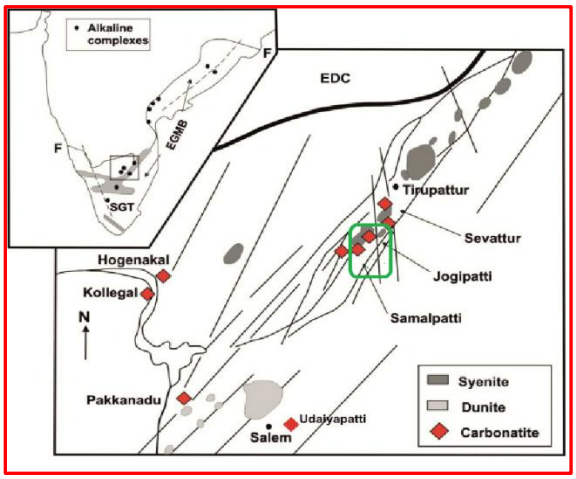


Figure 1. Geological map of the study area of Jogipatti, Samalpatti Complex. Structural relations of the carbonatites of Tamil Nadu indicating the syenite and dunite plugs with spatially related carbonatites (after Borodin et al., 1971 and Grady, 1971).

(A)

(B)

Figure 2. (A) An outcrop exposed with ferrous rich minerals of Fe-rich carbonatite rock body at Jogipatti area. (B) An outcrop showing dolomitic rich carbonatite at Jogipatti area.

(A)

(B)

Figure 3. Photomicrographs showing: (A) PPL, (B) XPL of Dolomite and Fe rich material in the carbonatites of Jogipatti.

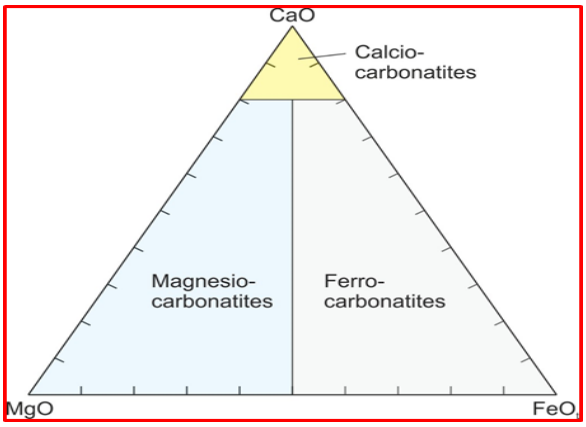
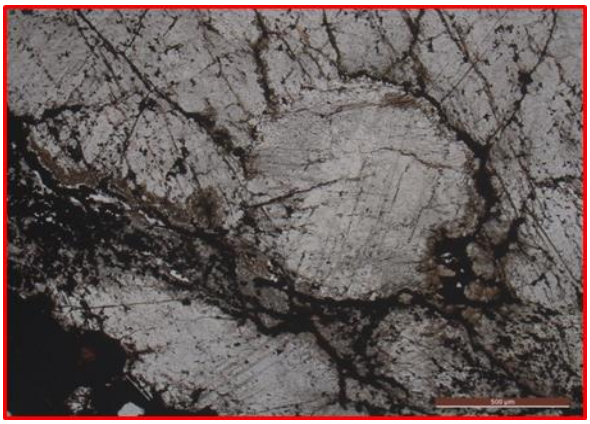


Figure 4. Carbonatite classification diagram showing the fields of calico, magnesio and ferro-carbonatite compositions after Woolley & Kempe (1989).

(C)



(D)

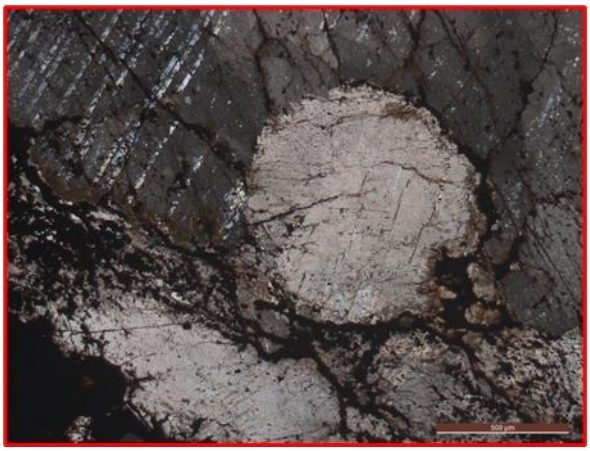


Figure 3.1 (C) PPL, (D) XPL of Calcite and Dolomite surrounded by Iron rich oxides in the carbonatites of Jogipatti area.

Class	Sub-division	Chemical characteristics
Calcio-carbonatite	Sövite (coarse-grained); Alvikite (medium- to fine-grained)	CaO /(CaO + FeO + MgO) >0.80
Dolomite carbonatite	Beforsite	$(Ca, Mg)CO_3$-rich
Ferro-carbonatite	-	$(FeO_t + MgO) > MgO$
Magnesio-carbonatite	-	$(FeO_t + MgO) < MgO$
Rare earth carbonatite	-	RE_2O_3 >1 wt. %
Natro-carbonatite	-	$(Na_2O + K_2O) > (CaO + MgO + FeO)$

FeOt= total iron, RE2O3 = total REE oxides.
Table 1: Carbonatite nomenclature, from Woolley & Kempe (1989) including rare earth and natro-carbonatites distinction Jones et al.(2013).

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