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Redox Series Assessment of Proterozoic Granite Gneiss and Cambrian Granite Plutons from Meghalaya Plateau, Northeast India: Insights from Field Relations and Magnetic Susceptibility Mapping

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Abstract

The Meghalaya Plateau including the Mikir Hills mainly comprises the Proterozoic granite gneiss, migmatites, metasediments, Cambrian granite plutons, and Mesozoic-Tertiary cover rocks. Field relationships and magnetic susceptibility (MS) mapping of granite gneisses, granites and related rocks of Meghalaya Plateau have been conducted in order to assess the redox series (magnetite, oxidized vs. ilmenite, reduced) nature of granites. The observed MS values of Proterozoic granite gneisses and Cambrian granites largely correspond to magnetite (>3.0×10^{-3} SI unit) series (oxidized type) and a few to ilmenite (<3.0×10^{-3} SI unit) series (reduced type) granites. The Cambrian granite plutons are dominated by magnetite series (>3.0×10^{-3} SI unit) series granites, which appear to have inherited primarily from the infracrustal (igneous) sources. However, the observed highly oxidizing (magnetite series) condition of granites from these plutons were most likely achieved during synchronous mixing and fractionation in open magma chamber, as evident from the presence of mafic to hybrid microgranular enclaves, and accumulation of ferromagnesian minerals. Fine to medium grained leucocratic granites measure low MS values (<3.0×10^{-3} SI unit) corresponding to ilmenite (reduced) series granite because of their evolved nature as being depleted in ferromagnesian (magnetic) minerals. At places, a few Cambrian granites hosting the pyrite and chalcopyrite measure a relatively higher MS values as compared to the unmineralized granites. Magnetite series granites are found to be reduced as ilmenite series close to its intrusive contacts with metasedimentary country-rocks.

Keywords: Magnetic Susceptibility, Redox Series Granites, Meghalaya Plateau, NE India

Introduction

Granites (*sensu lato*) are formed in varied tectonomagmatic environments ranging from Archean to Phanerozoic and essentially constitute an integral part of the continental crust. Granites are commonly bimodal in nature, and in terms of alumina saturation index (Shand, 1948) can be classified as metaluminous (I-type) and peraluminous (S-type) granites derived from partial melting of older igneous (infracrustal) and sedimentary source rocks respectively (Chappell and White, 1974, 2001). Magnetic susceptibility (MS) is a measure of magnetic properties of rock as magnetic or ferromagnetic and weakly magnetic or paramagnetic (Gregorová *et al.*, 2003). The MS value of granites is used to develop magnetite series (>3.0×10^{-3} SI unit) and ilmenite series (<3.0×10^{-3} SI) granites (Ishihara, 1977; Ishihara *et al.,* 2002) corresponding to oxidized-type and reduced-type granites respectively (Takagi and Tsukimura, 1997). The MS values primarily indicate redox conditions (oxygen fugacity) of felsic melts commonly inherited from source regions (Ishihara, 1979). In principle, magnetite and ilmenite series granites should be parallel to the I-type and S-type granites respectively, however, S-type magnetite series and I-type ilmenite series granites may also occur (Takahashi *et al.*, 1980). The alteration from magnetite series to ilmenite series of granites or vice-versa may be because of changing physico-chemical condition of magma chamber (Czamanske *et al.*, 1981, Carmichael, 1991), degassing or assimilation of wall-rocks *in situ* (Takagi, 2004), enroute or deeper-derived lithological assimilation, mafic-felsic magma mixing, and/or later tectonic processes acted upon them (Kumar *et al.*, 2005, 2006; Singh and Kumar, 2005; Kumar and Rino, 2007; Kumar and Singh, 2008, Kumar and Pathak, 2009, Kumar, 2010a-b; Kumar *et al.*, 2010; Anetsungla *et al.*, 2018; Panwar and Kumar, 2022). The MS value is therefore considered most powerful first-order discriminating parameter and can be potentially used to evaluate relative redox (magnetite *vs.* ilmenite series) conditions of granites and their likely association with mineralization, if any.

The Meghalaya Plateau including the upland of Mikir Hills is dominantly composed of Proterozoic granite gneiss (*ca.* 1900-1100 Ma), migmatites, granulites, metasediments, Cambrian granite

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