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Fabric analysis in rocks of the Gadag region (southern India) — Implications for time relationship between regional deformation and gold mineralization

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A B S T R A C T

In this paper, the fabric in Archaean age massive metabasalts and granite from the Gadag region (Western Dharwar Craton, southern India) are identified using the anisotropy of magnetic susceptibility (AMS). The magnetic foliation in the rocks is dominantly NW–SE striking. This is inferred to have developed during regional D1/D2 deformation known to have affected the region, which was on account of NE–SW shortening. The plunge of the magnetic lineation varies from NW to SE. This doubly plunging orientation is inferred to be a consequence of superimposition of NW–SE shortening (D3 deformation) over the earlier structure that is known to have resulted in dome-basin geometry in the surrounding metapelitic rocks of the region. Thus it is concluded that the massive rocks preserve evidence of superposed deformation that affected the region, which can be deciphered from the orientation of magnetic fabric data. The Gadag region comprises lode gold deposit (~2500 Ma in age), and field investigations show that the quartz veins are dilational with dominantly NW–SE (strike) orientation. The veins are inferred to have formed by dilation under NW–SE shortening during D3. It is envisaged that the NW–SE oriented fabric that formed in the metabasalt during D1/D2, channelized fluid flow, thus leading to vein emplacement during D3. It is concluded that gold deposition in the veins took place during D3, which is related to the final stages of cratonization of the Dharwar craton at ~2500 Ma.

1. Introduction

Establishing the time relationship between fabric development and regional deformation is an important aspect in structural geological investigations. This not only enhances our understanding of superposed deformations, but can also lead to a better appreciation of the relative timing of mineralization with respect to regional tectonics because the structural control on mineralization is well established (e.g., Cox et al., 1991, 2001; McCaffrey et al., 1999; Micklethwaite et al., 2010). However, several economically important ore deposits may occur in massive rocks that do not show well-developed (mesoscopic) fabric. As a consequence, analyzing fabrics in such rocks is challenging. In the past few decades, fabric in massive (visually isotropic) igneous rocks (e.g., granites, basalts, anorthosites, and gabbro) as well as massive quartzites has efficiently been identified using anisotropy of magnetic susceptibility (AMS), thus making AMS a useful petrofabric tool (e.g., Borradaile and Henry, 1997; Borradaile and Jackson, 2004; Bouchez, 1997; Cifelli et al., 2012; Ferré et al., 1999; Greiling et al., 2007; Henry et al., 2009, 2012; Hirt and Almqvist, 2012; Kratinová et al., 2012; Mamtani and Sengupta, 2010; Mamtani and Vishnu, 2012; Mukherji et al., 2004; Raposo et al., 2007; Tarling and Hrouda, 1993; Vishnu et al., 2010; Wilson et al., 2000; among others).

In the present study, we use AMS to analyze the fabric in massive rocks (metabasalts and granite) located in the Gadag region (Dharwar craton, southern India; Fig. 1). This is a province of gold mineralization, which has taken place in quartz veins within the metabasalt. It is known that pre-existing anisotropy in a rock can channelize fluid flow as well as lead to strength anisotropy (e.g., Cox et al., 2001; Sanderson and Zhang, 1999; Tsidzi, 1990). However, there has been no previous attempt to analyze the fabric in the metabasalt and granite, and evaluate its possible role in mineralization. Moreover, there is also no information available about how the fabric in granite is related to that in the metabasalt, and how these are related to regional tectonic events. The present study is aimed at filling these lacunae. Here AMS data are used to evaluate the time relationship between fabric development in the metabasalt and granite with respect to regional superposed deformation and vein emplacement/gold mineralization. This eventually helps provide the requisite information to investigate the relation between mineralization and cratonization of the Dharwar craton.

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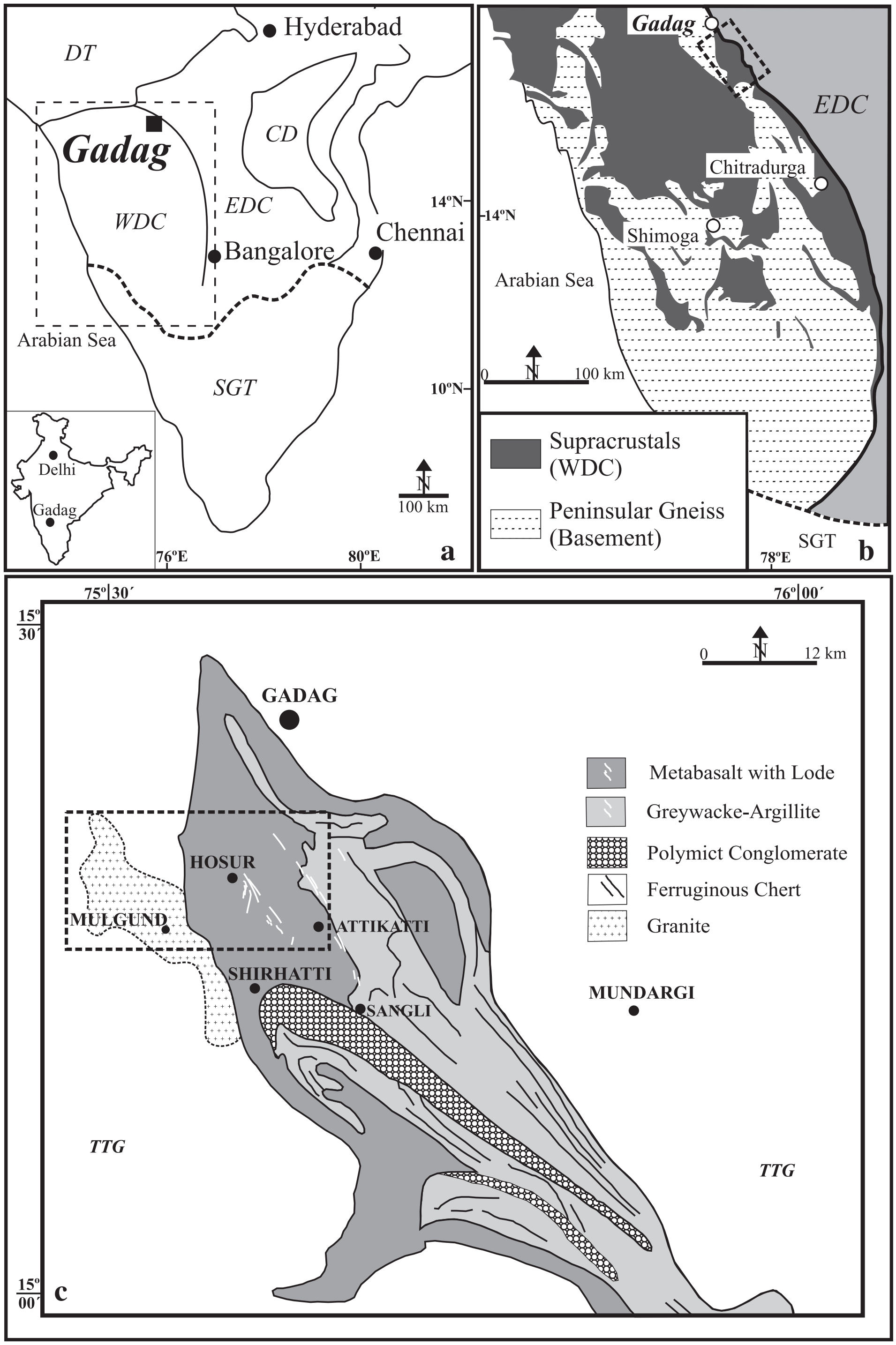

Fig. 1. (a) Location map of Gadag region in the southern Indian shield (after Sarma et al., 2012). Dashed line represents the Moyar Bhavani Shear Zone. SGT = Southern Granulite Terrain; EDC = Eastern Dharwar Craton; WDC = Western Dharwar Craton; CD = Cuddapah Basin rocks; DT = Deccan Trap basalts. Inset shows the map of India. Rectangular dashed box around Gadag demarcates the area shown in Fig. 1b. (b) Regional geological map of the Dharwar craton (after Chadwick et al., 2003). Dashed box near Gadag marks the Gadag schist belt that is shown in Fig. 1c. (c) Simplified geological map of the Gadag schist belt (modified after Curtis and Radhakrishna, 1993). White lines in the vicinity of Hosur and Attikati represent the gold bearing lodes of the Gadag schist belt. The dashed box enclosing the area around Hosur, Attikatti and Mulgund demarcates the region of study.

2. Geology of the study area

2.1. Regional geology — Southern Indian Shield

The study area is located in the Gadag schist belt. Regionally, this is a part of the Southern Indian Shield (Fig. 1), which comprises two major units — Dharwar craton and Southern Granulite Terrain (SGT) (Naqvi and Rogers, 1987). The Moyar Bhavani Shear Zone (dashed line in Fig. 1a) separates the Dharwar craton from the SGT, which is ~2500 Ma in age (2689 ± 26 Ma to 2501 ± 19 Ma; Plavsa et al., 2012) lying to its south. The oldest rocks of the Dharwar craton are the Peninsular Gneiss (3400–3000 Ma; Beckinsale et al., 1980; Sarma et al., 2011; Taylor et al., 1984). The Dharwar craton is considered to have formed by the accretion of East Dharwar Craton (EDC) and West Dharwar Craton (WDC) at 2750–2510 Ma. The zone of accretion is a shear zone, which is referred to as the Chitradurga Boundary Fault