Komatiites in the Sandstone greenstone belt, north-central Yilgarn Craton

by

S. F. Chen, P. A. Morris, and F. Pirajno

Adjacent Archean granite–greenstone terranes in the Yilgarn Craton contain contrasting abundances and types of komatiite. The Eastern Goldfields Superterrane (Cassidy et al., in prep.) contains relatively abundant, mostly aluminium-undepleted komatiites (AUDK) with both lenticular and sheet-like geometries (Nesbitt et al., 1979; Hill et al., 1990), whereas the Southern Cross Domain of the Youanmi Terrane (Cassidy et al., in prep.) contains less abundant komatiites comprising both AUDK and aluminium-depleted komatiite (ADK) types, such as the Forrestania greenstone belt, in the southern part of the domain (Perring et al., 1996).

Recent geological mapping, combined with exploration drillhole data, petrographic, and geochemical studies, has identified a sheet-like body (up to 10 × 30 km) of poorly exposed komatiites in the Sandstone greenstone belt (Fig. 1) that represents the most significant occurrence of komatiites so far recognized in the northern part of the Southern Cross Domain (Chen, 2005; Chen et al., 2005). Komatiites are structurally higher than, and appear to be discordant with, a mafic-dominated greenstone succession, but their exact stratigraphic relationship remains unclear due to poor exposure and structural complexity. The minimum age of the komatiites is constrained by a c. 2731 Ma age for a porphyritic microgranite that intrudes komatiites in the openpit of the Bulchina gold mine (Chen et al., 2005).

Komatiites in the Sandstone greenstone belt are commonly metamorphosed to greenschist facies, and have typically undergone serpentinization and talc–carbonate alteration, with localized chloritization and albitization. Little primary olivine is preserved. Serpentine, talc, and tremolite are the most abundant minerals, with phlogopite and calcite present in some samples. Accessory minerals include magnetite, titanite, anatase, and ilmenite. Despite metamorphism, alteration and locally intense deformation, relict olivine-spinifex and olivine-cumulate textures are commonly preserved.

Twenty-six komatiitic samples of chips from RAB and RC drillholes in the Sandstone greenstone belt have been analysed for major and trace elements. They contain greater than 18% MgO (Fig. 2a), and most samples have more than 2500 ppm Cr and 1000 ppm Ni. Despite alteration and metamorphism, komatiites

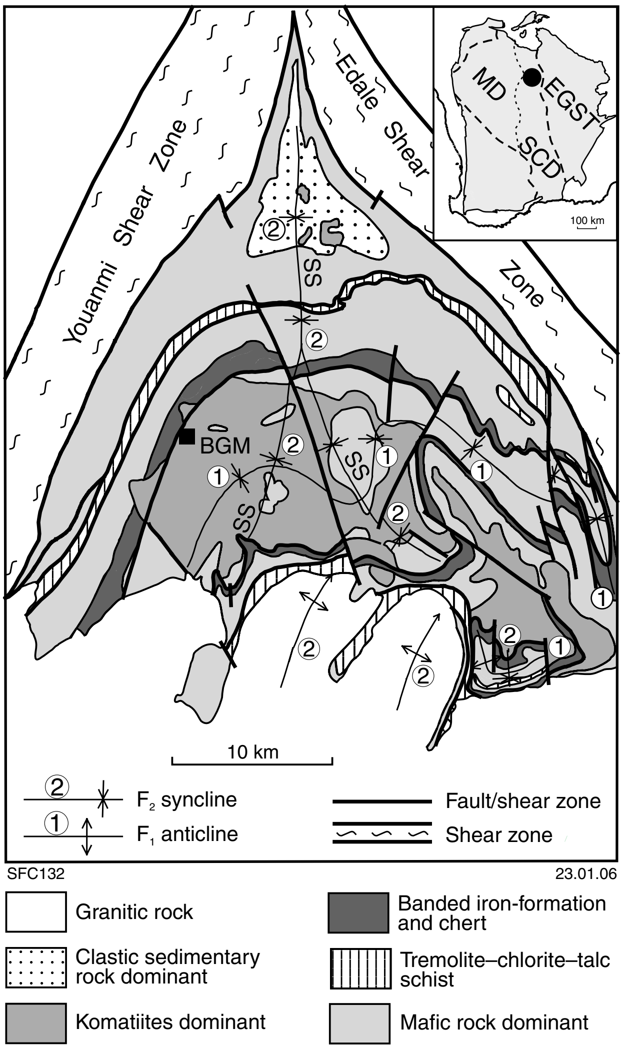

Figure 1. Interpreted geological map of the Sandstone greenstone belt. BGM — Bulchina gold mine; SS — Sandstone Syncline. Inset shows the location of the Sandstone greenstone belt (solid circle), and tectonic units of the Yilgarn Craton that are mentioned in the abstract: EGST — Eastern Goldfields Superterrane; MD — Murchison Domain; and SCD — Southern Cross Domain of the Youanmi Terrane

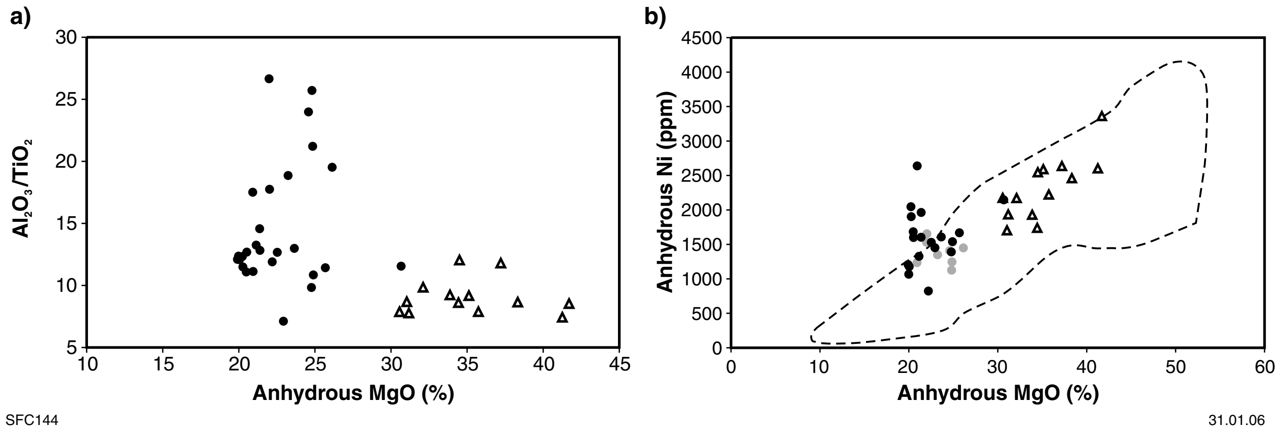

Figure 2. a) Al_2O_3/TiO_2 versus anhydrous MgO (%) for komatiites (solid circles) from the Sandstone greenstone belt (all oxide concentrations have been recalculated to 100% volatile-free), and komatiites from the Gabanintha ultramafic sequence (open triangles), Murchison Domain (Reudavey, 1990); b) anhydrous Ni (ppm) versus anhydrous MgO (%) for ADK (solid black circles) and AUDK (grey circles) from the Sandstone greenstone belt, and komatiites from the Gabanintha ultramafic sequence (open triangles; Reudavey, 1990). Dotted line is the 90th percentile for unmineralized AUDK from the Eastern Goldfields Superterrane (Barnes et al., 2004)

have consistent Zr/Nb, and Ti/Zr and Y/Ho (both close to primitive mantle), implying near-magmatic abundances of the rare earth elements (REE) and high field-strength elements (HFSE). Based on Al_2O_3/TiO_2, komatiites can be divided into ADK (Barberton type; Al_2O_3/TiO_2 <15) and AUDK (Munro type; Al_2O_3/TiO_2 of 15–25; Nesbitt et al., 1979; Sproule et al., 2002). Komatiitic samples from the Sandstone greenstone belt fall into both groups in terms of Al_2O_3/TiO_2 (Fig. 2a). ADK are indicative of melting at higher pressure where garnet is retained in the source or majorite garnet is a fractionating phase (Gruau et al., 1990), whereas AUDK represent melting at shallower depths or melting of a garnet-depleted source. Extraction of komatiitic magma at various depths (e.g. the dynamic melting) could explain the occurrence of both ADK and AUDK in the same greenstone belt (e.g. the Sandstone and Forrestania greenstone belts).

Barnes et al. (2004) have examined the chemistry of mineralized and barren komatiites from the Eastern Goldfields Superterrane. Some komatiitic samples from the Sandstone greenstone belt plot within the 90th percentile envelope for 903 analyses of S-poor (i.e. unmineralized) Eastern Goldfields AUDK (Barnes et al., 2004; Fig. 2b), but some analyses (both AUDK and ADK) plot at higher Ni for a given MgO. Barnes et al. (2004) have argued that the higher Ni of such samples results from the presence of Ni-rich sulfides. Moreover, many komatiitic samples from the Sandstone greenstone belt have greater than 20% MgO and greater than 1000 ppm Ni, which also enhances their Ni-sulfide potential, because this is the range commonly observed for mineralized komatiitic rocks (Lesher et al., 1999).

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