Exploration significance of the Hiltaba Suite, South Australia

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The recently completed 'Metallogenic potential of Australian Proterozoic granites' project highlighted the 1590-Ma Hiltaba Suite and Gawler Range Volcanics (GRV) in the Gawler Craton as having high potential for further substantial mineral finds. This extensive magmatic entity comprises two (geochemical) types with apparently different mineralisation associations (Fig. 1). The strongly oxidised (hematite–magnetite) and fractionated Roxby Downs type is related to Fe-oxide–Cu–Au deposits (including the giant Olympic Dam deposit). The Kokatha type is less oxidised (ilmenite–titanomagnetite) and fractionated, and is associated with vein-hosted Au (± Sn ± Ag) deposits such as Earea Dam, Glenloth, and Tarcoola. Understanding the distribution of these two magmatic types has implications for the selection of exploration models to apply to a particular area.

The Hiltaba volcanic–plutonic event

Volcanics and granites of the Hiltaba Suite (Drexel et al. 1993: Geological Survey of South Australia, GSSA, Bulletin 54)

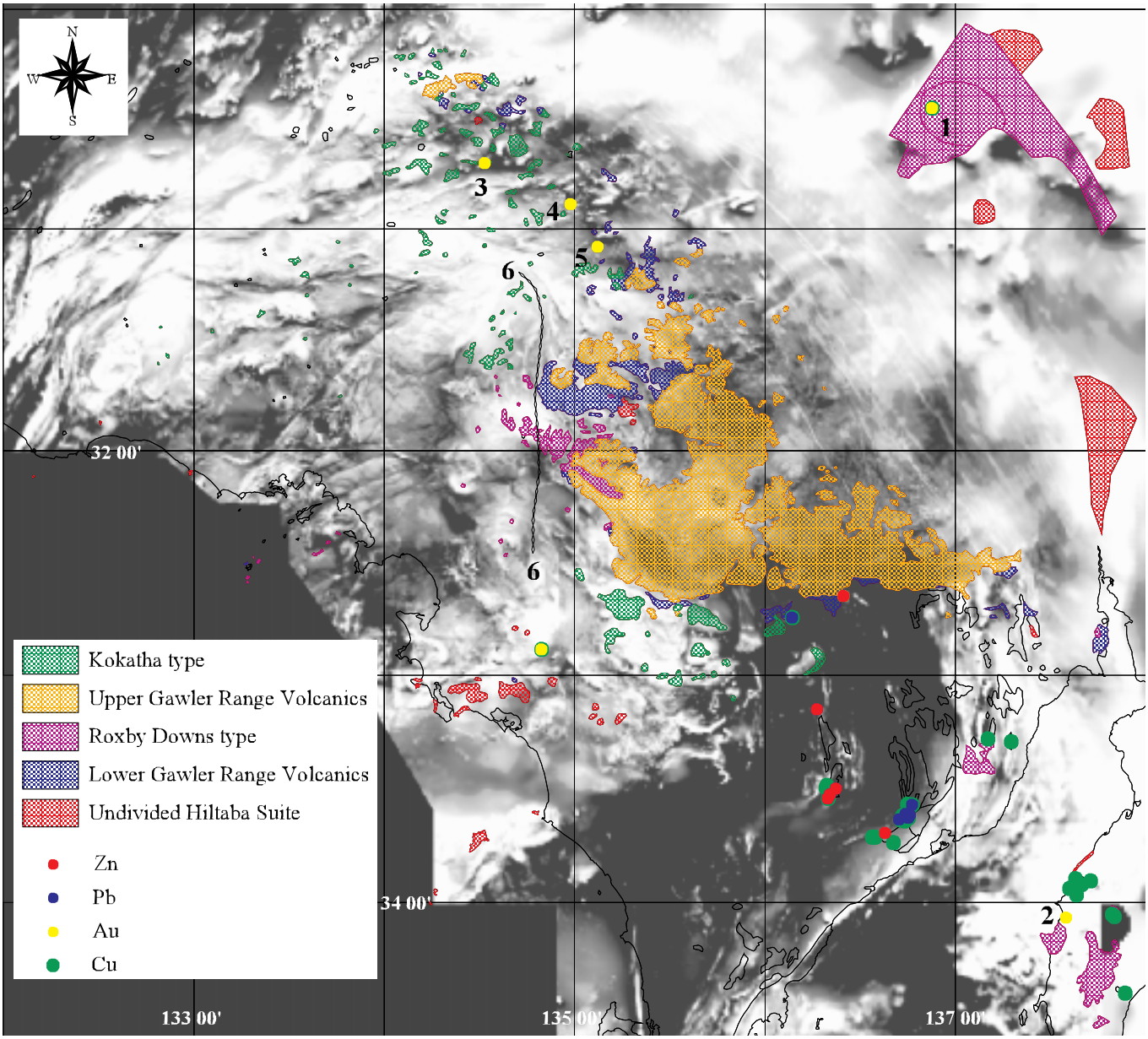

Fig. 1. Distribution of the Hiltaba Suite types and associated mineral deposits in the Gawler Craton overlain on an image derived from AGSO's 'Australian national aeromagnetic' dataset: 1, Olympic Dam Cu–Au; 2, Moonta–Wallaroo Cu–Au; 3, Tarcoola Au; 4, Earea Dam Au; 5, Glenloth Au; 6: Yarlbrinda Shear Zone Au prospects. Mineral locations from the AGSO/BRS MINLOC database.

occur throughout the Gawler Craton, and probably extend to the Curnamona Province — including the Olary domain (Wyborn et al. 1998: in AGSO Record 1998/25, 124–129) and the Mount Painter subprovince.

The Roxby Downs type is composed of the following recognised granites: Moonta monzogranite (Drexel et al., 1993: op. cit.), Charleston Granite, granite at Cultana, Hiltaba Granite, Tickera Granite, Arthurton Granite, granite in the Olympic Dam area (including the Roxby Downs Granite, and Wirrda and White Dam subsuites), and granite in the Nuyts Archipelago area. The Balta and Calca Granites, for which no geochemical analyses are available, are probably also of this type. The 'lower GRV' ('development' phase of Stewart 1992: PhD thesis, University of Adelaide) is comagmatic with this type.

The Roxby Downs type includes granite (*sensu stricto*), syenogranite, quartz monzodiorite, quartz monzonite, syenite, aplite, monzogranite, and leucotonalite. Coarse-grained, porphyritic, and megacrystic varieties are common. Unlike the Kokatha type, granites of this type are commonly altered, contain hematite and magnetite, and are a distinctive brick-red colour. The Roxby Downs type is more enriched in Rb and the high-field-strength elements (HFSE) U, Th, Zr, Nb, and Ce, and more fractionated, than the Kokatha type (Fig. 2). It is mostly metaluminous, and strongly oxidised, having evolved to magmatic compositions in which hematite was the stable iron oxide. The 'lower GRV' is magnetite-stable (Stewart 1992: op. cit.), and ranges in composition from basalt and andesite to dacite, rhyodacite, and rhyolite with a variable silica gap between the tholeiitic basalt–andesite series and the felsic series. Felsic lithologies dominate.

The Kokatha type is composed of the following recognised granites: granite in the Kokatha, Tarcoola, Kingoonya, Kychering Rockhole, Minnipa, Wudinna, and Buckleboo areas. The 'upper GRV' ('mature' phase of Stewart 1992: op. cit.) is comagmatic with this type.

The Kokatha type comprises syenite, granodiorite, monzogranite, and granite (*sensu stricto*). Grainsize ranges from medium to coarse, and porphyritic textures are common. The granites are white to pink, and pyrite is a common accessory, indicating that they are more reduced than the Roxby Downs type. The type is less fractionated (lower Rb, U, Nb, and Ce at equivalent wt% SiO_2 are good indicators; see Fig. 2) than the Roxby Downs type, and mostly peraluminous. The 'upper GRV' comprises flat-lying sheets of massive porphyritic dacite and rhyodacite, crops out more extensively than the 'lower GRV' (much of which it probably overlies), and is ilmenite- and titanomagnetite-bearing (Stewart 1992: op. cit.).

Both suites of granites contain common accessory fluorite and apatite.

Similarities to Curnamona Province granites

The most extensive granitoids in the Olary domain (Curnamona Province) were emplaced at ~1590 Ma, and constitute the so-called 'regional S-type suite' (Ashley et al. 1997: Minerals & Energy South Australia, MESA, Report Book 97/17). These rocks have considerable similarities to the Hiltaba Suite (Wyborn et al. 1998: op. cit.) both in their age and geochemical characteristics. They are probably equivalent to the Kokatha type of the Hiltaba Suite.

In the northwest Curnamona Province, granites were emplaced at ~1560 Ma in the Mount Painter and Mount Babbage inliers of the Mount Painter subprovince (Teale 1993: in GSSA Bulletin 54 (1), 149–156 & 93–100). Though younger than the Hiltaba Suite, they are similarly fractionated, mostly oxidised, I-type, fluorite-bearing, and enriched in HFSE. They are associated with occurrences of anomalous Sn, Cu, F, W, U, Y, Mo, and REE representing a variety of mineralisation styles (Teale 1993: op. cit.). However, the mineralisation's age and relationship to the granites are poorly constrained.

Mineralisation

The temporal and spatial association between granites of the Hiltaba Suite and Fe-oxide–Cu–Au deposits such as Olympic Dam (Johnson & Cross 1995: Economic Geology, 90, 1046–1063), Moonta–Wallaroo (Conor 1996: "The Palaeo–Mesoproterozoic geology of northern Yorke Peninsula, South Australia: Hiltaba suite-related alteration and mineralisation of the Moonta–Wallaroo Cu–Au district. Resources '96 — field excursion 2–3 December 1996", MESA, Adelaide), and Acropolis, Wirrda Well, Emmie Bluff, Oak Dam, and Murdie (Gow et al. 1994: Geology, 22, 633–636) has been recognised for some time. Likewise, the temporal and spatial association between Hiltaba Suite granites and vein Au (± Sn ± Ag) deposits has been demonstrated by work at Earea Dam (Daly 1993: in GSSA Bulletin 54, 138–139), Tarcoola (Daly 1993: op. cit.), Glenloth (Daly 1993: op. cit.), along with recent discoveries on the Yarlbrinda Shear Zone (Martin 1996: in "Resources '96 Convention, Adelaide, 4–5 December 1996, Abstracts", MESA, Adelaide, 90–93). However, the recently completed Proterozoic granites project is the first to recognise the correlation of different styles of mineralisation with different chemical types of the Hiltaba Suite.

Conclusions and proposed further work

The Hiltaba Suite (granites and comagmatic volcanics) comprises two types, each correlating with a distinct mineral association. The more oxidised Roxby Downs type is associated with Fe-oxide–Cu–Au deposits; the less oxidised Kokatha type is associated with vein Au (± Sn ± Ag) deposits. The project has also identified probable extensions of the Hiltaba Suite in different areas of the Curnamona Province. This information should assist the application of exploration models in these areas.

We suggest that the geochemistry, geochronology, and geological setting of these granites and their host rocks throughout the Gawler Craton and Curnamona Province should be assessed in conjunction with detailed studies of the mineralisation associated with these granites. This in turn would assist in understanding how the magma evolved and ultimately provide more robust exploration models for these areas. Such a multidisciplinary approach has been effective in the Cloncurry district (Wyborn 1998: Australian Journal of Earth Sciences, 45, 397–411) and Pine Creek Inlier (Stuart-Smith et al. 1993: AGSO Bulletin 229). Further, detailed studies of the physical rock properties of the granites, their hosts, and the associated mineral systems will provide the knowledge necessary to interpret geophysical datasets in the areas of deep cover so prevalent in all these areas.

Acknowledgments

This paper has resulted from the joint AGSO/State and Territory 'Metallogenic potential of Australian Proterozoic granites' project sponsored by 20 companies. It reflects contributions from Sue Daly, Colin Conor, Wayne Cowley, Martin Sheard (Primary Industries & Resources, South Australia,) Paul Ashley (University of New England), and Kathy

Stewart (University of Adelaide), whom we thank for their assistance. Roger Skirrow (AGSO) reviewed the manuscript. The full results of the project are being compiled for release as an AGSO Record on CD–ROM.

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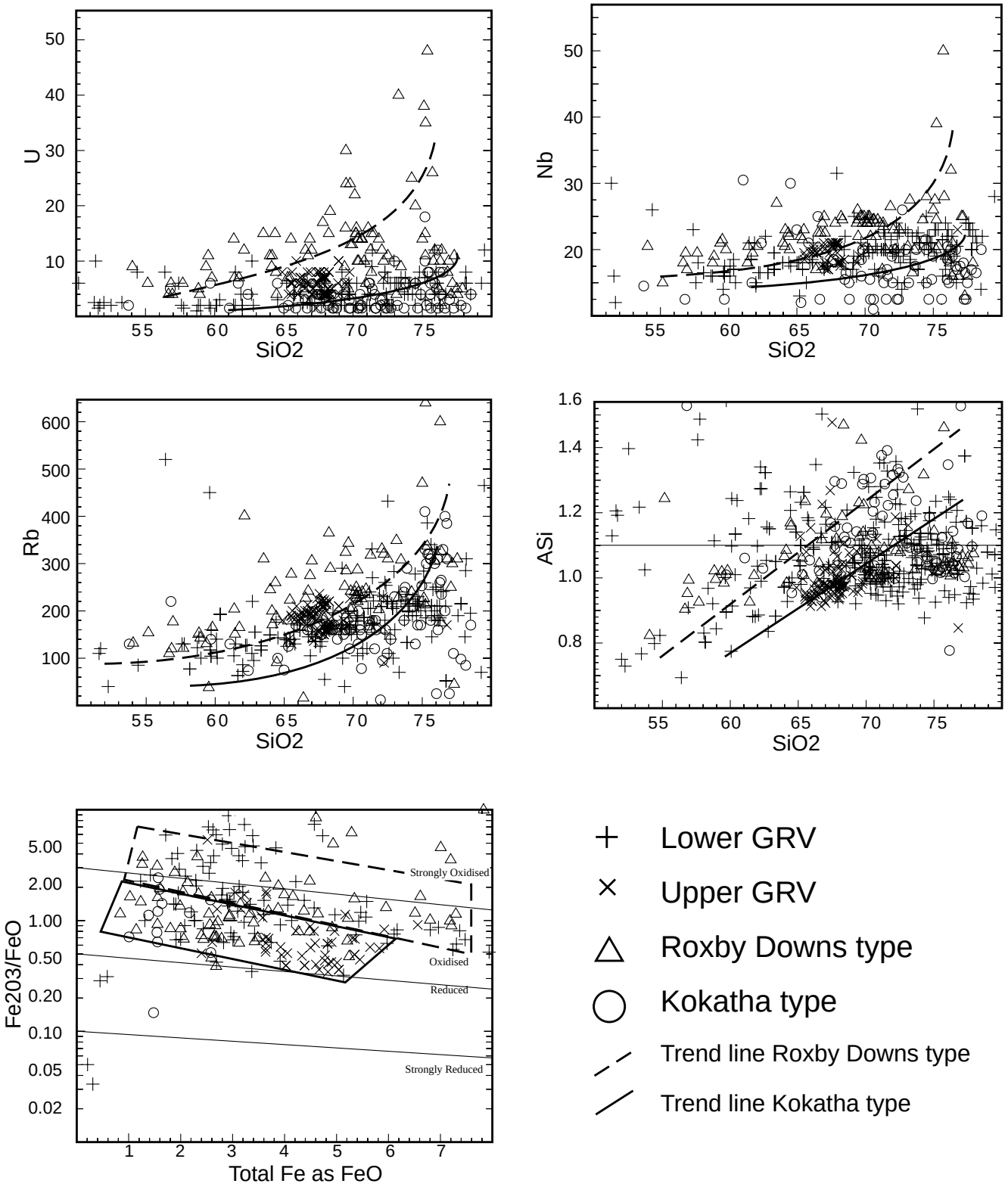

Fig. 2. Geochemical variation diagrams discriminating between the two geochemical types in the Hiltaba Suite.