Reply to “Comments on the use of gamma-ray spectrometry for tin and tungsten prospecting”

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Introduction

In previous studies comparing the radiometric signatures of exposed “barren” and Sn/W (as wolframite) mineralized granitoids in southeast Australia (Collins et al 1981; Yeates 1982; Yeates et al 1982) it was demonstrated that the uranium value of a granitoid is significant in terms of its suitability as a source of, or host to, associated mineralization. Prospective granitoids have more than 4 or 5 p.p.m. U (in various areas) and the abundance of U can be measured simply in the field with a portable four-channel gamma-ray spectrometer housing a sufficiently-sized NaI crystal detector (Collins et al 1981, pp. 3–4).

In this note, we reply to criticism that Yeates et al (1982) did not evaluate their U measurements in terms of Mo–W (as scheelite) and Sn–F–W (as wolframite in veins and greisens, and scheelite in skarns) mineral deposit associations commonly found with “I- and S-type” granitoids respectively, where mineralized (Webster 1984). We also correct other errors in Webster’s critique that are relevant to this topic.

Futility of granitoid and related mineral deposit groupings in the Lachlan Fold Belt

In the Lachlan Fold Belt, various groupings of the granitoids have been applied for some time. They have been based on many different attributes as is evident in the reviews by Crook and Powell (1976, pp. 5–8) and Griffiths (1977, table 1). The various characteristics show overlap when compared (Crook & Powell 1976, table 0–2).

Without giving reasons for his preference, Webster (1984) used the regional grouping of Suppel and Degeling (1982) [unavailable to Yeates et al (1982) when proofs were returned] that utilises the “I- and S-type” concept of Chappell and White (1974). In the latter it is stated (p. 174): “Tin mineralisation appears to be confined to highly siliceous S-type granites whereas tungsten and porphyry-type copper and molybdenum deposits are associated with I-types”. It appears that Webster (1984) has accepted this unsubstantiated sentence as unchallengeable. He has also erroneously shown that the ilmenite-series granitoids of Ishihara (1977) equate with “S-types” only (Webster 1984, table 1) when Takahashi et al (1980) have shown that they can also be “I-types”. This is one example of the kind of overlap in granitoid characteristics that exists in the Lachlan Fold Belt.

In our study of the NSW segment of the Lachlan Fold Belt (Yeates et al 1982) we purposely avoided evaluating our gamma-spectrometric data in terms of any available classification because of known non-uniqueness and overlap in characteristics, especially in the most felsic granitoids.


Also, many masses in the region have still to be studied sufficiently before they can be assigned “I- or S-types”.

The distribution of Sn, W, Cu and Mo occurrences associated with granitoids in the Fold Belt is well known from Markham and Basden (1974) and the 1:250 000 scale Metallogenic and Geological maps. These publications show examples of Sn, W (as wolframite), Cu, and Mo occurring in vein deposits of mineralized granitoids in all three of Suppel and Degeling’s granitoid domains, and slightly contrary to data in Webster (1984, table 1).

For instance, Sn occurs with Cu, Mo, and W (as wolframite) at several deposits near Holbrook in the far west of the Fold Belt (Degeling 1974, 1976; Weber et al 1978). The host of these deposits, the composite Koottong Granite, is currently designated an “S-type” (Chappell & White 1976). On currently available information, therefore, other factors must be invoked to explain these Cu and Mo occurrences. Alternatively, a greater density of sampling may reveal another type of granitoid in their environments.

Wolframite is the principal constituent of a vein deposit whose host is the Burrinjuck Adammellite in Suppel and Degeling’s “Central Belt of S- and I-types” (Bowman 1974). This pluton has been designated an “I-type” and contains 6 p.p.m. U (Owen & Wyborn 1979). Much farther north, the Gumble Granite is host to both Sn and Cu/Mo (Packham 1968). This too is an “I-type” (White & Chappell 1983, fig. 2 and table 1).
In Suppel and Degeling's "Eastern Belt of I-types", the I-type Bega Batholith (Chappell & White 1976) is host to two wolframite deposits in which molybdenite is an accompanying mineral (Weber et al. 1978). One of these, "the Hammond and Standens claim", occurs close to occurrences of alluvial Sn. The adjacent drainage pattern shown on the Bega 1:250 000 scale Metalogenic Map indicates that the source of the Sn must lie within the Batholith. Thus W (as wolframite) and Sn occur in a host that is part of a well-sampled batholith currently designated an "I-type".

**U abundances of granitoids that are the sources of W (as scheelite)**

In northwest Tasmania, and in New England, it was revealed that granitoids with associated scheelite mineralization cannot always be distinguished radiometrically from "barren" plutons (Collins et al 1981; Yeates 1982). The Crassly Granodiorite at King Island, with 7-12 p.p.m. U, and the Attunga Creek Adamellite and Inlet Monzomite in New England, with U values ranging from 6 to 8 p.p.m. (Chappell 1978), are examples of several that do have enriched U. Webster (1984) has ignored these data and stated (p. 62) that "granitoids hosting Cu–Mo–W (tungssten, as scheelite) are not anomalous in uranium content". We presume that by the term "anomalous" Webster meant 'significant' or 'enriched' [e.g. 4-30 p.p.m. as qualified by Yeates et al (1982), p. 1728].

In the northeast of the Lachlan Fold Belt, there are several stocks, some of which are notable for associated Cu–Mo–W (as scheelite) deposits (Stevens 1974). They are satellite to the main outcrop of the Bathurst Batholith, and White and Chappell (1983, fig. 2, table 1) have designated them "I-types". At least three of these stocks have enriched U, i.e. greater than 4 p.p.m. (Bunker et al 1975; Facer 1977; Bateman 1982, table 1; Yeates et al 1982, table 1; Wyatt et al 1984) contrary to Webster's claim. Another stock in this area for which no U abundance has been published is likely the source of alluvial Sn at Meadow Flat (Stevens 1974) showing also that Sn is not excluded from this cluster of "I-type" granitoids. This is also consistent with enriched U (7.48 p.p.m.) in the "I-type" Gumble Granite, which is the source of Cu and Mo mineralization as well.

Whereas most scheelite associated with I-type granites in the region is present in skarns, another type of occurrence has recently been found by Dr D. Wyborn and B. Turner. In the Tantangara district (southwest Canberra 1:250 000 Sheet area) the Boggly Plain I-type Suite of granitoids (Owen & Wyborn 1979) includes a leucogranite with accessory scheelite, high U (up to 15 p.p.m.) and a uranium accessory mineral (Wyborn 1983). Accessory scheelite is also present in part of the Euguowra Granite (east Forbes 1:250 000 Sheet area). The scheelite-bearing phase here also contains up to 15 p.p.m. of U (Turner 1983). It is expected that accounts of these occurrences will be available shortly (Wyborn et al. in press).

Sn–W mineralization in the Lachlan Fold Belt is associated with granitoids enriched in U regardless of their type, as currently designated. Though Chappell (1984) maintains the "igneous" parentage of "I-types" and the "sedimentary" parentage of "S-types" he noted that the geochemical characteristics of each tend to merge and overlap as they become highly fractionated (and potentially mineralizing). They may therefore be difficult to distinguish (Plant et al. 1983). Kwak and White (1982, fig. 1) have shown that Sn tends to be associated with the more reduced granitoids compared to W. The more reduced types are mainly "S- and A-types" but they can sometimes be "I-types", whereas the more oxidised types are usually "I-and A-types" but can rarely be "S-types". This scope for overlap may explain the mineral deposit associations discussed above.

**Treatment of data acquired by Yeates et al (1982)**

Yeates et al (1982) assessed the U values of the region's granitoids in terms of their location in geophysical domains 1 and 2 of Wyatt et al (1980). This scheme was used only because it was a convenient way of treating a large body of data, and because it was another opportunity to draw attention to one of the great geophysical boundaries (Wyatt et al 1980, fig. 3) within the Tasmanides of Eastern Australia. [See Powell (1983) for further discussion of the boundary.]

This division is independent of the mineralogy of deposits containing Sn, W, Cu, Mo etc. and to the granitoids being "I-, S-, or A-types", though "S-types" appear to be common in Domain 2.

**Conclusion**

This review has shown that Sn, W (as wolframite), Cu, and Mo can all be associated with granitoids designated "I-types" or "S-types" in the Lachlan Fold Belt of NSW.

It is therefore maintained that Webster's criticisms cannot be substantiated. In the Lachlan Fold Belt, no one type of granite, as currently designated, is completely exclusive to Sn–F–W (as wolframite) or to Cu–Mo–W (as scheelite). Also, there are known difficulties in deciding whether fractionated leucogranites are "I- or S-types" (Plant et al 1983; Chappell 1984). We maintain that explorationists should prospect the environments of granitoids enriched in uranium, regardless of their type.

**Acknowledgments**

We thank Dr D. Wyborn and Mr B. Turner for generously allowing us to quote from their unpublished theses. Both they and Dr L. Wyborn are thanked for discussions, and for reading an earlier draft. The paper is published with the permission of the Director, Bureau of Mineral Resources, Canberra.

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