Exploration Geophysics (1984) **15**, 61-63

Note

Comments on the Use of Gamma-Ray Spectrometry for Tin Prospecting

S. S. Webster

Geological Survey of NSW
GPO Box 5288
Sydney
NSW 2001

Key words: gamma-ray spectrometry, tin mineralization, tungsten mineralization, granitoids, south-east Australia

Introduction

A model has been proposed (Webster 1982) to utilize geophysical data for tin exploration. The model incorporates a diagnostic magnetic signature for tin deposits (Webster 1984) combined with the magnetic patterns of granitoids. Regional gravity and magnetic data can be utilized to define favourable geology and structural environments for epigenetic mineralization.

An alternative approach using gamma-ray spectrometry has been proposed to identify favourable granitoids for the occurrence of tin and tungsten mineralization. The main south-east Australian tin provinces have been extensively sampled by Collins *et al.* (1981) (north-west Tasmania), Yeates *et al.* (1982) (Lachlan Fold Belt, NSW) and Yeates (1982) (New England Batholith, NSW). These studies have been interpreted to indicate that granitoids with equivalent uranium content in excess of 4 p.p.m. to be prospective in the New England district, whilst 5 p.p.m. is the threshold for north-west Tasmania and the Lachlan Fold Belt. It was concluded, however, that anomalous radioactivity was not evident for granitoids with associated tungsten, as scheelite, mineralization.

TABLE 1

Granitoids and mineralization

Ishihara (1977)	Chappell and White (1974)	Mineralization (skarn and veins)
Magnetite series	I-type	W - Cu - Mo Au? W skarns scheelite veins scheelite
	A-type	
Ilmenite series	S-type	Sn - W - F W skarns scheelite veins wolframite

Granitoids and mineralization (Table 1)

Tin and tungsten mineralization can be grouped into two contrasting assemblages associated with equally different granitoids. Kwak and White (1982) showed a general association of W - Mo - Cu skarn deposits with I-type (Chappell & White 1974) or 'magnetite-series' granitoids. In contrast, the W - Sn - F skarn deposits are associated with A- or S-type granites generally equated to the 'ilmenite series' of Ishihara (1977). Similar mineral and granite associations have been observed with the vein and breccia deposits of the Lachlan Fold Belt (Suppel & Degeling 1982).

A mineral association of significance, in the Lachlan province, is for tungsten in W - Mo - Cu skarns and veins to occur as scheelite. In the W - Sn - F mineral association tungsten occurs as scheelite in skarns but, mainly, as wolframite in vein deposits.

Another important feature of the proposed model is for the mineralization to be associated with late phases of otherwise barren granitoids. In north-west Tasmania and the Lachlan Fold Belt these mineralizing phases are rarely observed to outcrop which may restrict the application of the radiometric method in defining mineralized phases of granitoids.

Radiometric studies

Lachlan Fold Belt

In the radiometric studies of Yeates *et al.* (1982) and Yeates (1982) no distinction was made between the two mineral associations described above, though some recognition was given to the different granitoids. As cited by Kwak and White (1982), uranium, and other rare-earth elements, are diagnostic of the W - Sn - F mineral association. Thus it is expected that a higher background radioactivity would be observed in the vicinity of these deposits and related granitoids.

The subdivision of the Lachlan Fold Belt used by Yeates *et al.* (1982) is based on characteristics of regional gravity and magnetic maps of the area. An alternative subdivision based on the geology of granitoids (Suppel & Degeling 1982) (Fig. 1), would equate Domain 2 with the Western Belt of S-type granitoids and predominantly Sn - W - F vein, mineralization. Thus the observation that these granitoids show > 5 p.p.m. equivalent uranium content is consistent with the mineral association.

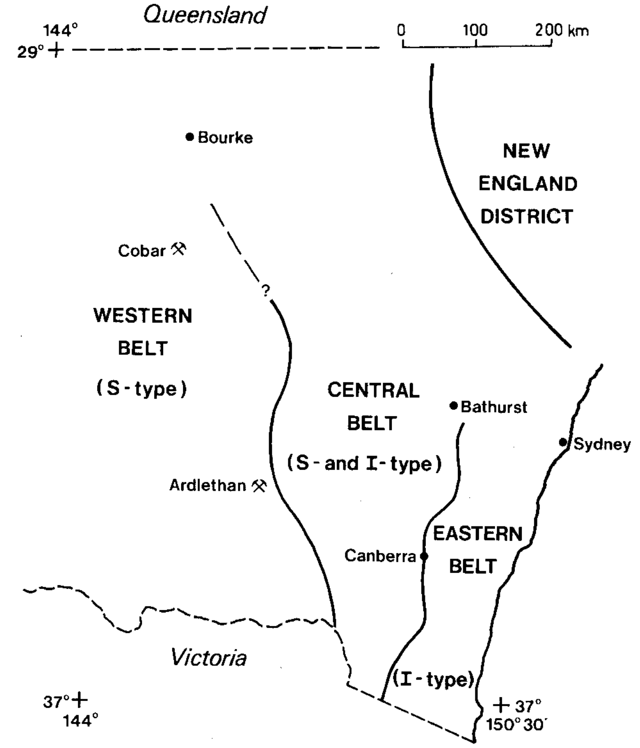

FIGURE 1

Granite domains, Lachlan fold belt, NSW. (After Suppel & Degeling 1982.)

However, the Domain 1, of Yeates *et al.* (1982), comprises the Central Belt of mixed I-type and S-type granitoids (and related W - Mo - Cu mineralization) and the Eastern Zone of mainly (non-mineralized) I-type granitoids.

The general absence of uranium in the W - Mo - Cu mineralization may explain the data scatter in samples measured by Yeates *et al.* (1982) in Domain 1 of the Lachlan Fold Belt, and the grouping of spectrometric data from these overlapping provinces may explain the lower threshold of > 4 p.p.m. equivalent uranium.

New England

The New England Batholith (Shaw & Flood 1981) comprises both I-type and S-type granitoids and leuco-adamellites, the latter having similar characteristics to the A-type granites of Collins *et al.* (1981). The economic mineral association is predominantly a vein tin association with leuco-adamellites plus minor wolframite.

Yeates (1982) observed that the tin and tungsten (wolframite) mineralized granitoids had a higher equivalent uranium content (> 4 p.p.m.) than the barren granitoids (< 4 p.p.m.).

A study of airborne radiometric data (Slade 1982) from the New England district showed distinctly different K, Th, U radioactivity spectra for the leuco-adamellites (as typified by the Mole Granite) compared to non-mineralized granites (Fig. 2).

This spectral difference will be examined in further analysis of the airborne data, as the superior statistics should complement the widely scattered data of Yeates.

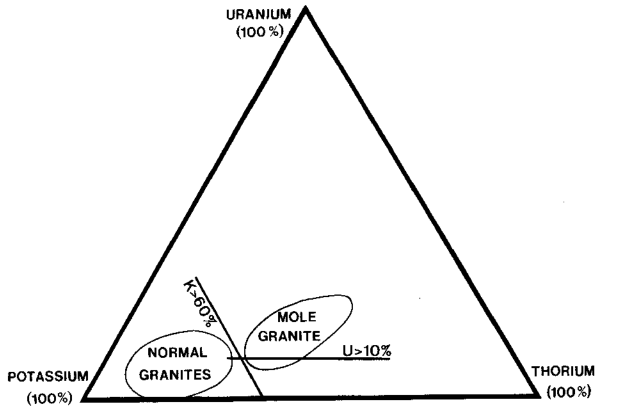

FIGURE 2

New England granites. Uranium - thorium - potassium percentages from airborne radiometric survey. (After Slade 1982.)

Conclusion

It would appear, from the above discussion, that radiometric spectra (and intensity) may reflect changes in granite type or origin rather than the presence of tin or tungsten mineralization. This is especially true in central NSW where the mineralizing late phases do not outcrop and the parent granitoid is often barren. Highly anomalous intensity may, of course, be evident in the case of outcropping mineralized granitoids.

On an empirical basis it is often true that the radiometric data for tin and tungsten granitoids show:

(a) a higher uranium content for hosts of Sn - W - F mineralization;

(b) granitoids hosting Cu-Mo-W (tungsten, as scheelite) are not anomalous in uranium content; and

(c) spectral characteristics differ between mineralized and non-mineralized granitoids, at least in the New England Batholith.

Further statistical analysis of the considerable airborne radiometric data available may provide a tool to supplement the proposed geophysical model for tin exploration. The use of combined airborne magnetic and radiometric data, in mapping granite types, will be studied jointly by the University of New England and the NSW Geological Survey.

Acknowledgment

This paper is published with the approval of the Secretary of the Department of Mineral Resources.

References

Chappell, B. W. & White, A. J. R. (1974), 'Two contrasting granite types', *Pacific Geol.* **8**, 173-4.

Collins, P. L. F., Wyatt, B. W. & Yeates, A. N. (1981), 'A gamma-ray spectrometer and magnetic susceptibility survey of Tasmanian granitoids', Tasmanian Department of Mines, unpubl. Report 1981/41.

Ishihara, S. (1977), 'The magnetite-series and ilmenite-series granitic rocks', *Mining Geol.* **27**, 293-505.

Kwak, T. A. P. & White, A. J. R. (1982), 'Contrasting W-Mo-Cu and W-Sn-F skarn types and related granitoids', *Mining Geol.* **32**, *339-51.*

Shaw, S. E. & Flood, R. M. (1981), 'The New England batholith, eastern Australia: geochemical variations in time and space', *J. Geophys. Res.* **86**, 10530-544.

Slade, J. (1982), Geophysical review of the New England block, J. Slade & Assoc., Report, Nov. 1982.

Suppel, D. W. & Degeling, P. (1982), 'Comments on magmatism and metallogenesis of the Lachlan fold belt, NSW' (abstract), *in* S. R. Sangameshwar (ed.) *Geology and Mineralization in the Lachlan Fold Belt, NSW.* GSA Abstract No 6, 4-5.

Webster, S. S. (1982), 'A geophysical signature for tin exploration?', NSW Geol. Survey. Unpubl. Report GS 1982/217.

Webster, S. S. (1984), 'A magnetic signature for tin deposits in south-east Australia' *Explor. Geophys.* **15**, 000-000.

Yeates, A. N. (1982), 'Radioelement characteristics of tin and tungsten granitoids in the New England batholith, and other granitoid provinces of south-east Australia, Voisey Symposium, 1982, New England.

Yeates, A. N., Wyatt, B. W. & Tucker, D. H. (1982), 'Application of gamma-ray spectrometry to prospecting for tin and tungsten granites, particularly within the Lachlan Fold Belt, NSW', *Econ. Geol.* **77**, 1725-38.

(Received 12 October 1983)