LEAD AND STRONTIUM ISOTOPE STUDIES IN THE LACHLAN FOLD BELT

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Lead (and U-Pb) isotope data for sulphides and whole rocks, U-Pb data for zircons, and Rb-Sr data for whole rocks have been determined in an attempt to elucidate the processes by which the volcanic Pb-Zn-Cu deposit at Woodlawn, south-eastern NSW, was formed, and to relate this information to current theories of crustal effects in the genesis of volcanic Pb-Zn deposits.

The lead-isotope compositions of pyrite, galena, sphalerite, and chalcopyrite from the ore horizon are the same, and identical to the initial lead isotope compositions of pyrite in the host volcanics.

Linear relations are obtained on volcanic whole rock plots of $^{207}Pb/^{204}Pb$ vs $^{206}Pb/^{204}Pb$, $^{208}Pb/^{204}Pb$ vs $^{206}Pb/^{204}Pb$ and $^{238}U/^{204}Pb$ vs $^{206}Pb/^{204}Pb$, indicating no loss or gain of U to these rocks since their formation. The similar initial $^{206}Pb/^{204}Pb$ ratios in the sulphides and host volcanics suggest a common source for the lead. However, acid leach experiments suggest these to be a complex mixture of ore and rock lead.

U-Pb data for zircons from the whole rocks give a spectrum of 'ages' ranging from 428 to 477 m.y., reflecting varying amounts of older zircons or resetting of the U-Pb systems in the volcanics. The older zircons may be present either as discrete rounded crystals or as cores surrounded by new euhedral growth. The populations and U-Pb data suggest the volcanic rocks at Woodlawn were derived from pre-existing volcanics with a possible detrital component, which have not been fully reset during remelting.

In contrast to the zircon data, U-Pb and Rb-Sr whole rock data define lines proportional to ages of 413 ± 10 m.y. and $\sim$ 400 m.y. (Rb/Sr decay constant = 1.42×10^{-11}/yr), respectively. The strontium has a relatively high initial ratio of $\sim$ 0.710.

The complex zircon population, high initial Sr ratio, Th/U ratios and 'rare earth' data, suggest the Woodlawn volcanics were formed by remelting of similar volcanic material. Consequently, to discuss conformable deposits of this type in terms of the "Growth Curve" and single-stage models of lead development is invalid.

Mineralization is thought to have occurred at $\sim$ 420 m.y., either from solutions associated with the volcanism, or concentrated from the volcanics by circulating sea water, in a shallow convective cell and soon after, or during, the formation of the pile.

FLUID INCLUSIONS IN THE GRANITIC ROCKS OF THE LACHLAN FOLD BELT

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Very little is known of the complex history of fluid interaction with the rocks of the Lachlan Fold Belt. In this survey we have examined the nature and abundance of the fluids trapped as inclusions in the granitic rocks of south-eastern NSW and Victoria. Some hundreds of specimens have been examined in thin section, embracing examples of Vallance's (1969) Bathurst, Murrumbidgee and Cooma granite types, together with leucogranites and other distinctive variants. Selected doubly-polished thick sections were used in homogenization temperature measurements and salinity determinations, using heating and freezing stages, respectively.

Fluid inclusions were found in the quartz grains of all granitic rocks examined. Six compositional types are distinguishable:

(1) liquid only;
(2) two-phase liquid/vapour;
(3) low-density gaseous;
(4) CO_2-rich;
(5) multiphase of low salinity;
(6) highly saline.

Inclusions of types 1, 2 and 3 are ubiquitous, but types 4 to 6 are restricted to certain granites. Inclusions of glass and devitrified glass are uncommon.

Although occasional inclusions larger than 100μm in length were observed, the vast majority are smaller than 10 μm in the longest dimension. The mean inclusion size appears to give an indication of depth of emplacement. Fewer fluid inclusions are found in the quartz grains of the more mafic rocks (diorites and tonalites) than in their leuocratic associates.

Inclusions range in shape from stumpy negative crystals to those with ragged or irregular outlines, but most are more or less rounded. The most irregular are the type 1 variety, which represents the lowest temperatures of formation. The overwhelming proportion of all types homogenize at less than 300°C, and, in general, the more regular the inclusion shape, the higher the homogenization temperature. Pressure corrections of up to +250°C may be appropriate for homogenization temperatures measured from deeper-level granites, but, for type 2 inclusions in the Icely Granite (part of the Bathurst Batholith) that homogenize at 280 ± 5°C, this correction is only of the order of +30°C.

Salinities of the fluids in inclusions of types 1, 2 and 5 are low to moderate, in the range 0-10% equivalent NaCl. However, a few granites contain highly saline (type 6) inclusions with NaCl daughter crystals and occasionally KCl as well. These highly saline inclusions are not characteristic of any granite composition or emplacement type.

An examination of the areal distribution of distinguishable fluid types reveals that type 4 inclusions are particularly characteristic of the Bathurst type granites. They are also common in the high-level granites of central Victoria and the Mt Wills area of northeastern Victoria. These granites may also be of the Bathurst type.

It is not possible to prove that any of the fluid inclusions had a primary magmatic origin, but some, especially the irregularly dispersed higher-temperature inclusions, are related to initial cooling, as distinct from crystallization, of the host quartz grains. Most, however, are demonstrably secondary in origin, as they lie along curved fracture planes or along the traces of such planes that have now healed. By studying cross-cutting relationships between these planes as well as various textural characters of the rock, it is possible to infer relative times of origin of the inclusions. The usual situation is that the fluids now observed were trapped after the development of mature textures. In samples of the deformed granites, particularly the Burrinjuck-Young, Murrumbidgee and Wyangala Batholiths, most of the inclusions occupy fracture planes formed after the deformation of the quartz. In the deformed parts of the Barry and Wondalga Granites, however, where recrystallization is well advanced, some fluids were obviously included after deformation but before recrystallization.

A magmatic source seems most likely for the highly saline and CO_2-rich types. The abundant low-salinity inclusions could well be due to influx of meteoric waters at some later stage. Possibly some inclusion fluids may have exsolved from the solid phases in the cooling granitic bodies.

Distinctive fluid inclusion assemblages characterized by high salinity and gas-rich inclusions are typical of Bingham-type porphyry copper host rocks. However such assemblages have not yet been observed in the Lachlan Fold Belt, even from mineralized granites.

SOME PROCESSES OF ROCK DEWATERING AND OREBODY FORMATION IN THE LACHLAN GEOSYNCLINE

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