THE ORIGIN OF THE GEOLOGICAL STRUCTURES, DIAPIRS, GRABENS, AND BARITE VEINS IN THE FLINDERS RANGES, SOUTH AUSTRALIA

by

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ABSTRACT

The Adelaide Fold Belt in South Australia consists of a sequence of sedimentary rocks from Neoproterozoic to Cambrian in age, deposited on a granitic basement and deformed by two shortening deformations during the 500-480 Ma Delamerian Orogeny. Significant features of the Fold Belt, especially in the central Flinders Ranges, are a large number of barite vein deposits and mud breccia deposits known as diapirs.

During the D_1 deformation, a series of F_1 gentle folds were formed with NNW orientation. Fractures and faults trending NNE and ENE were also formed across F_1 anticlines, initiating boundary faults for grabens on both limbs of the anticlines. Sequences on limbs of anticlines, but dominantly those on eastern limbs, and within boundary faults of grabens, were thrust over décollement faults, forming a series of imbricate type fault-propagation folds, verging WSW, and grabens across the axial traces of anticlines. Décollement faults that formed over the basement continued as listric thrust faults through the sedimentary sequence, up to Cambrian aged sediments. Breccia was produced during gouging along these thrust surfaces, and included basement rocks and Neoproterozoic sedimentary rocks. The breccias were subsequently deposited along the décollement faults, in the cores of anticlines, adjacent to apices of grabens and extruded into adjacent hosts.

Structures produced by the D_2 deformation include major F_2 gentle, fault-propagation folds oriented ENE, and superimposed onto F_1 folds to form dome and basin egg-carton-like structure, thus remobilising breccia, dominantly into domes. The D_2 deformation also caused a series of dextral kinks along F_1 axial traces, including the Nackara Arc.

Barite veins were mainly formed in three sets of essentially unconnected and near-vertical tensional fractures, following the antitaxial mechanism, during NE-SW major compression of the D_1 deformation. The dominant set was oriented NE-SW, while two subordinate en échelon sets were formed with NNE and ENE orientations in conjugate shear zones. The veins were then subjected to displacement and rotation during progressive deformation, especially within the grabens, thus producing a complex vein array as shown by the Oraparinna deposits in Bunkers Graben of the central Flinders Ranges.

The most favourable host stratigraphic unit for barite veins in the Adelaide Fold Belt is the Brachina Formation, accounting for approximately 60 % of barite production+reserves. Siltstone, alone or in association with other lithologies, mainly shale, is the most important

lithology, hosting approximately 70 % of barite production+reserves. Siltstone is the dominant lithology in the Brachina Formation. K-feldspars in the Brachina Formation contain up to 1.2 wt% Ba and are the most likely source of Ba^{2+} ions which migrated into vein-depositional sites during deformation.

Barite veins of the Adelaide Fold Belt are characterized by a simple mineralogy, consisting of barite with minor, but variable, amounts of carbonates and quartz, and only trace amounts of sulphide minerals. $^{87}Sr/^{86}Sr$ ratios of the veins range from 0.710695 to 0.733382 and $\delta^{34}S$ values of barite range from 16.8 to 31.0 ‰. The combined isotope data suggest both Sr^{2+} and SO_4^{2-} ions were derived mainly from host formations and connate waters of marine origin, but in some cases Cambrian seawater and/or diapirs may have been additional sources of these components. Fluid inclusion data indicate the veins formed from fluids with temperature of less than 150°C.

Dilational fractures that host the barite veins formed abundantly near both the décollement and listric thrust fault surfaces along which most of the diapirs were produced. However, the supply of ingredients to the veins was limited to those veins within about 100 m from diapirs, as seen at the Oraparinna Diapir in the central Flinders Ranges.

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