

Continuous metamorphic gradient documented by graphitization and K-Ar age, southeast Otago, New Zealand

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ABSTRACT

The Chrystalls Beach–Brighton coastal section, southwest of Dunedin, New Zealand, exposes Otago Schist, including the weakly metamorphosed Triassic accretionary melange of the Chrystalls Beach Complex and higher-grade rocks of a largely felsic, arc-derived provenance. Melange zones contain pelagic sediments, some of which are manganiferous, and metabasites. The grade of metamorphism increases progressively from southwest to northeast. Four mineral zones are recognized largely on the basis of mineral assemblages in psammitic and semipelitic rocks: pumpellyite-chlorite, pumpellyite-actinolite, epidote-actinolite, and biotite. d_{002} data for carbonaceous material, b_0 values for phengite, and metamorphic phengite K-Ar ages are reported for 32 pelitic and semipelitic samples. Remarkably tight correlations are revealed between d_{002} for progressively graphitized carbonaceous material, K-Ar ages that range from 184.6 to 138.7 Ma, and linear distance along the section. Both the d_{002} values and the K-Ar ages decrease progressively toward the northeast through the four mineral zones and with progressive textural changes. All rocks cropping out in the section have undergone a coherent episode of progressive metamorphism associated with terrane collision and have not been disturbed by any later major displacements. A convex trend for phengite b_0 values plotted against advancing graphitization suggests P/T conditions during metamorphism as in the high-pressure intermediate facies series. The age of the metamorphic peak is inferred to be 175–155 Ma (Middle to Late Jurassic), with cooling to the mica closure temperature at 155–135 Ma (Late Jurassic to Early Cretaceous). Unloading, denudation, and cooling were accompanied by localized hydrothermal events. The oldest covering strata were deposited at ca. 100 Ma and denudation was completed by ca. 75–80 Ma. Middle Triassic radiolarian nodules in melange zones are dated as preceding the metamorphic peak by about 65 Ma. Associated turbidites contain suspected late Middle to early Late Triassic tube fossils.