Biostratigraphic subdivision of the Ordovician System in Australia incorporating water depths and facies

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Abstract

During the Ordovician, the western two-thirds of the present-day continent of Australia consisted of numerous intracratonic sedimentary basins interspersed among the Archean and Proterozoic cratons forming the core of northeastern Gondwana. Eastern Australia, comprising the majority of the states of Queensland, New South Wales, Victoria and Tasmania, consisted of several extensive orogens including Ordovician sedimentary, volcanic and volcaniclastic rocks that accreted to the cratonic margins. To establish precise biostratigraphic correlations across an area equivalent to much of Europe, encompassing a variety of facies and water depths, has occupied the authors and their colleagues for much of the past 30 years. This project, focused on conodont biozonation, is now in its concluding stages.

The late Tremadocian to latest Floian conodont biozonation In shallow-water carbonate-dominated shelfal environments of the Canning, Arafura and Amadeus intracratonic basins has been established over the past two decades with revision and integration of previous systematic studies. The zonal succession, from oldest to youngest, comprises the *Paroistodus proteus*, *Prioniodus oepiki–Serratognathus bilobatus*, *Oepikodus communis*, and *Jumudontus gananda* biozones. Conodont biozonation of shelfal carbonate successions of the Delamerian Orogen along the cratonic margin in western NSW extends from the latest Furongian into the Floian but remains to be more finely resolved.

Middle Ordovician shallow-water conodonts were widespread across the Australian palaeocontinent, extending to New Zealand, with seven conodont biozones recognized. Dapingian and lower Darriwilian biozones are defined in the intracratonic basin sequences of the Canning, Amadeus and Georgina Basins, succeeding the *Jumudontus gananda* Biozone that ranges into the lower Dapingian. The *Histiodella altifrons* Biozone extends through the upper Dapingian into the basal Darriwilian. Younger biozones in the Darriwilian, in decreasing order of age, are the *H. holodentata–E. pseudoplanus* Biozone, *Eoplacognathus suecicus* Biozone, *Pygodus serra* Biozone and lower *P. anserinus* Biozone. Darriwilian 2 conodonts representative of the *H. holodentata–E. pseudoplanus* and three younger biozones are also found in carbonates of the Macquarie Volcanic Province in central NSW, and in limestones of the Takata Terrane in New Zealand.

The Late Ordovician shallow-water conodont biozonation of eastern Australia comprises seven biozones that are contiguous except in the middle Sandbian and upper Katian. The upper *Pygodus anserinus* biozone extends from the latest Darriwilian. Late Sandbian to middle Katian biozonation includes (from the oldest) the *Belodina compressa*, *Phragmodus*

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undatus–Tasmanognathus careyi, *Taoquopognathus philipi*, *T. blandus*, and *T. tumidus–Protopanderodus insculptus* biozones. The youngest biozone, of latest Katian age, is the *Aphelognathus grandis* Biozone. These conodont biozones have counterparts in North China, South China, and in the North American midcontinental faunas.

Utilising the widespread occurrence of conodont elements in cherts and siliceous mudstones of deep-water basinal environments, a conodont biozonal scheme has recently been established to subdivide the turbiditic successions of the Lachlan Orogen of eastern Australia into 12 superbiozones and biozones. In ascending order these are the *Paracordylodus gracilis* Superbiozone (including the *Prioniodus oepiki* Biozone), *Periodon flabellum* Superbiozone (including the *Oepikodus evae* Biozone in the lower part), *Periodon hankensis* Biozone, *Periodon aculeatus* Superbiozone (including the *Histiodella labiosa*, *H. holodentata*, *H. kristinae*, *Pygodus serra* and *Pygodus anserinus* biozones) and the *Periodon grandis* Biozone. This new conodont biozonation scheme spans the upper Tremadocian to middle Katian interval and permits precise age-dating and correlation of deep-water siliciclastic rocks that characterize the Ordovician Open-Sea Realm both regionally and internationally. The Darriwilian deep-water biozonation mirrors, but is not identical to, that defined in shallow-water carbonate successions, particularly in the succession of *Histiodella* species. The lower Darriwilian (Dw1) *H. labiosa* Biozone is succeeded by the *H. holodentata* Biozone (Dw2) and *H. kristinae* Biozone (Dw2). The subsequent two *Pygodus biozones* (*P. serra* and lower *P. anserinus*; Dw3) are the same as those recognised in shallow-water carbonates. The upper *Pygodus anserinus* Biozone extends into the basal Sandbian and is succeeded by the *Periodon grandis* Biozone.

The Ordovician graptolitic succession in Victoria, comprising 31 biozones covering the entire system, is globally recognised as the Pacific Graptolite Province. Occasional co-occurrence of conodonts with graptolites on bedding planes enables precise tie points to be established with the Victorian graptolite biozones, with the graptolite biozonation spanning facies of intermediate water depths between the shelfal carbonate environments and the deep-water basinal depths typified by cherts and siliciclastic sedimentary deposits.

Keywords: Ordovician, biostratigraphy, conodont, graptolite, biofacies, carbonate rocks, chert, Australia, New Zealand