

New Middle Permian - Early Triassic U-Pb zircon CA-IDTIMS isotopic ages of tuffs in the Sydney Basin, Australia: International calibration of stratigraphy and biostratigraphy

I. Metcalfe^{1,2}, R.S. Nicoll^{3,4}, J. Crowley⁵, M. Ives⁶, D. Mantle³, K. Ruming⁷, M. Huyskens⁴ & C.B. Foster^{3,8}

¹ *Earth Sciences, Univ. New England, Australia*

² *Earth and Planetary Sciences, Macquarie Univ., Australia*

³ *Geoscience Australia, Canberra*

⁴ *Research School of Earth Sciences, Australian National Univ., Canberra*

⁵ *Department of Geosciences, Boise State Univ., U.S.A.*

⁶ *Centennial Coal Company Ltd, Toronto, Australia*

⁷ *Mineral Resources Division, NSW DPI, Maitland*

⁸ *Earth and Environment, Univ. Western Australia, Perth*

The Middle Permian-Early Triassic (MP-ET) of Eastern Australia contains a predominantly endemic biota precluding precise correlation with standard international biozones and System/Stage boundaries. The Permian-Triassic boundary, other MP-ET stage boundary levels, and the major end-Guadalupian and end-Permian mass extinction levels in Australia remain poorly constrained. Attempts to calibrate the MP-ET of Australia using Sensitive High Resolution Ion Microprobe techniques have resulted in controversial radioisotopic ages with percent-level uncertainty and compromised accuracy due to the use of an unsuitable standard. We here report eighteen new high-precision (± 0.05 my) U-Pb CA-IDTIMS ages for tuffs in the Sydney Basin based on isotopic dating of chemically abraded individual zircons. These dates provide vital international timescale tie points for the MP-ET of Australia. The youngest samples from the Garie Fm (c. 247.7 Ma, c. 248.0 Ma) give a late Early Triassic (late Spathian) age. The youngest Permian age is c. 252.6 Ma from the Mannering Park Tuff. Two samples from the prominent Awaba Tuff are tightly grouped at c. 253 Ma. An age of c. 253 Ma for the Nalleen Tuff confirms the previous stratigraphic and geochemical correlation with the Awaba Tuff. The prominent Nobbys Tuff in the Newcastle Coal Measures, is dated as c. 255 Ma which is latest Wuchiapingian. The oldest dates obtained are c. 263.4 Ma from the Broughton Fm and c. 271.4 Ma for the Rowan Fm, both older than the Guadalupian-Lopingian boundary of c. 260 Ma. Implications of these ages for calibration of stratigraphy and biostratigraphy, intra and inter basin correlations, placement of mass extinction levels, sedimentation rates, dating of environmental and climate change (including glaciation) and the degree of intensity of volcanism in the late Permian of the Sydney Basin are presented.

Late Permian U-Pb CA-IDTIMS isotope geochronology of the Bowen Basin, Eastern Australia

I. Metcalfe^{1,2}, R.S. Nicoll^{3,4}, R. Mundil⁵, S. Denyszyn⁵, J. Crowley⁶, D. Mantle³, R. Willink⁷, & C.B. Foster^{3,8}

¹ *Earth Sciences, Univ. New England, Australia*

² *Earth and Planetary Sciences, Macquarie Univ., Australia*

³ *Geoscience Australia, Canberra*

⁴ *Research School of Earth Sciences, Australian National Univ., Canberra*

⁵ *Berkeley Geochronology Center, Berkeley, U.S.A.*

⁶ *Department of Geosciences, Boise State Univ., Boise, U.S.A.*

⁷ *Origin Energy, Milton, Australia.*

⁸ *School of Earth and Environment, Univ. Western Australia*

High-resolution geochronology with an age resolution at the permil or sub-permil levels has the potential to internationally calibrate Late Permian peri-Gondwanan sequences in the Bowen Basin. Previous attempts at such calibration have relied on carbon-isotope records and very tenuous biostratigraphic and lithostratigraphic correlations here deemed unsuitable for a high-resolution chronostratigraphic framework for the basin. Existing SHRIMP U-Pb ages for some tuffs in the basin have been compromised by inaccuracy and low precision when compared to the CA-IDTIMS method. High-precision CA-IDTIMS ages also allow us to correlate individual tuff beds across the basin, to estimate sedimentation rates of packages of strata, and to estimate rates of climatic and biotic change between the late Guadalupian and late Changhsingian major Permian mass extinctions. We here report seven new U-Pb CA-IDTIMS ages for ash-fall tuffs in the Late Permian of the Bowen Basin. Our youngest age, c. 252.2 Ma from the top of the Bandanna Formation essentially equates with the Permian-Triassic boundary. Our oldest date so far, c. 257.3 Ma, from the Ingelara Formation, equates with the early Wuchiapingian Stage. The major northern marker Platypus Tuff has been dated at c. 256.6 Ma indicating a mid-Wuchiapingian age, and a date of c. 256.4 Ma from a 1 meter thick tuff in the Wallabella Coal Member of the Tinowon Formation in the south confirms previous suggestions that these tuffs are equivalents. Our preliminary date of c. 254 Ma for a tuff near the base of the Black Alley Shale approximately equates with the base of the Changhsingian Stage. Our new CA-IDTIMS ages indicate that the Late Palaeozoic glaciation period (top of P4) may be earliest Changhsingian in age dating the last glacial event and the transition from "Icehouse" to Greenhouse" conditions in eastern Gondwana to be younger than previously interpreted.