Forum

U-Pb zircon ages from the southwestern Karoo Basin, South Africa—Implications for the Permian-Triassic boundary: COMMENT

COMMENT: doi: 10.1130/G30973C.1

Roger Higgs
Geoclastica Ltd, 1 Church Path, Bude, Cornwall EX23 8LH, UK

Fildani et al. (2009) proved the Permian and Triassic age of the Ecca Group. However, the claim of providing "the first evidence of a marine Permian-Triassic (P-T) boundary in the Karoo Basin" (Fildani et al., 2009, p. 719) is doubtful.

Fildani et al. referred repeatedly to the Ecca Group in the southwestern part of the Karoo foreland basin as "marine." However, marine fossils are known only near the base, suggesting fresh or brackish water for the rest of the time (McLachlan, 1973; McLachlan and Anderson, 1973; Visser, 1989). Many authors have interpreted much of the southern and southwestern Ecca Group as lacustrine (Lake Karoo of Higgs, 2008), based on paleontological and/or geochemical evidence (Marchant, 1978; Kingsley, 1981; Visser, 1989; Veevers et al., 1994; Faure and Cole, 1999; Braddy and Briggs, 2002). A modern analog proposed by Tankard et al. (1982) for part of the Ecca Group is the Black Sea, whose salinity varied from fresh to brackish during late Quaternary time due to variable eustatic overtopping of the Bosphorus sill (Aksu et al., 2002). The deposits of such "sea-level lakes" (Goldring, 1978) can contain thin (centimeter to decimeter) marine bands, reflecting extreme eustatic highs, while lowstands are characterized by fresh water (Higgs, 1991).

One of the formations sampled by Fildani et al., the Skoorsteenberg, is popular as an outcrop analog for deep-sea-turbidite petroleum reservoirs, with profound economic implications (Higgs, 2009). The Skoorsteenberg deep-sea-fan model (after Bouma and Wickens, 1991) was accepted by Fildani et al., despite the lack of reported marine fossils, and despite their own Late Permian age coinciding with the lowest long-term eustatic sea level of Phanerozoic time (Miller et al., 2005; Haq and Schutter, 2008), favoring disconnection from the ocean by along-strike orogenic salients. Johnson et al. (2001; co-author in common with Fildani et al.) interpreted the Skoorsteenberg Formation as marine based on 11 reported (but not illustrated) ichnogenera: *Chondrites*, *Cosmorhaphe*, *Gordia*, *Granulana*, *Gyrochorte*, *Helminthoida*, *Helminthoides*, *Helminthopsis*, *Lophoctenium*, *Lorenzinia*, and *Paleodictyon*. Reviewing this list, Buatois et al. (2010) considered *Chondrites*, *Lophoctenium*, and *Lorenzinia* invariably marine. However, *Chondrites* and *Lophoctenium* also occur in strata interpreted as fresh and brackish (Archer and Maples, 1984; Pemberton et al., 2001). Regardless, thin marine bands would be unsurprising in the Skoorsteenberg Formation, representing exceptional eustatic highs. The known Skoorsteenberg ichnofauna differs significantly from the conventional marine shelf (*Cruziana*), slope (*Zoophycos*), and basin plain (*Nereites*) ichnofacies. Two elements (*Gordia*, *Helminthopsis*) are typical of the (fresh) lacustrine *Mermia* ichnofacies (Buatois and Mángano, 1995); others will surely be discovered.

REFERENCES CITED

Aksu, A.E., Hiscott, R.N., Mudie, P.J., Rochon, A., Kaminski, M.A., Abrajano, T., and Yasar, D., 2002, Persistent Holocene outflow from the Black Sea to the eastern Mediterranean contradicts Noah's Flood Hypothesis: GSA Today, v. 12, no. 5, p. 4–10, doi: 10.1130/1052-5173(2002)012<0004:PHOFTB>2.0.CO;2.

Archer, A.W., and Maples, C.G., 1984, Trace-fossil distribution across a marine-to-nonmarine gradient in the Pennsylvanian of southwestern Indiana: Journal of Paleontology, v. 58, p. 448–466.

Bouma, A.H., and Wickens, H.D., 1991, Permian passive margin submarine fan complex, Karoo Basin, South Africa: Possible model to Gulf of Mexico: Transactions—Gulf Coast Association of Geological Societies, v. 41, p. 30–42.

Braddy, S.J., and Briggs, D.E.G., 2002, New Lower Permian nonmarine arthropod trace fossils from New Mexico and South Africa: Journal of Paleontology, v. 76, p. 546–557, doi: 10.1666/0022-3360(2002)076<0546:NLPNAT>2.0.CO;2.

Buatois, L.A., and Mángano, M.G., 1995, The paleoenvironmental and paleoecological significance of the lacustrine *Mermia* ichnofacies: An archetypical subaqueous nonmarine trace fossil assemblage: Ichnos, v. 4, p. 151–161, doi: 10.1080/10420949509380122.

Buatois, L.A., Netto, R., and Mángano, M.G., 2010, Ichnology of late Paleozoic post-glacial transgressive deposits in Gondwana: Reconstructing salinity conditions in coastal ecosystems affected by strong meltwater discharge, *in* Lopez Gamundi, O., and Buatois, L.A., eds., Late Paleozoic glacial events and postglacial transgressions in Gondwana: Geological Society of America Special Paper 468, (in press).

Faure, K., and Cole, D., 1999, Geochemical evidence for lacustrine microbial blooms in the vast Permian Main Karoo, Paraná, Falkland Islands and Huab basins of southwestern Gondwana: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 152, p. 189–213, doi: 10.1016/S0031-0182(99)00062-0.

Fildani, A., Weislogel, A., Drinkwater, N.J., McHargue, T., Tankard, A., Wooden, J., Hodgson, D., and Flint, S., 2009, U-Pb zircon ages from the southwestern Karoo Basin, South Africa—Implications for the Permian-Triassic boundary: Geology, v. 37, p. 719–722, doi: 10.1130/G25685A.1.

Goldring, R., 1978, Sea level lake community, *in* McKerrow, W.S., ed., The ecology of fossils: London, Duckworth, p. 178–181.

Haq, B.U., and Schutter, S.R., 2008, A chronology of Paleozoic sea-level changes: Science, v. 322, p. 64–68, doi: 10.1126/science.1161648.

Higgs, R., 1991, The Bude Formation (Lower Westphalian), SW England: Siliciclastic shelf sedimentation in a large equatorial lake: Sedimentology, v. 38, p. 445–469, doi: 10.1111/j.1365-3091.1991.tb00361.x.

Higgs, R., 2008, Permian "deep-sea-fan" turbidites, Karoo Basin, South Africa, reinterpreted as lake-shelf hyperpycnites (extended abstract), *in* Zavala, C. et al., eds., Sediment Transfer from Shelf to Deepwater—Revisiting the Delivery Mechanisms: American Association of Petroleum Geologists Hedberg Conference, Ushuaia, Argentina, March 2008: Search and Discovery Article #90079.

Higgs, R., 2009, Multiscale stratigraphic analysis of a structurally confined submarine fan: Carboniferous Ross Sandstone, Ireland: Discussion; American Association of Petroleum Geologists Bulletin, v. 93, p. 1705–1709, doi: 10.1306/06240908114.

Johnson, S.D., Flint, S., Hinds, D., and Wickens, H.D., 2001, Anatomy, geometry, and sequence stratigraphy of basin floor to slope turbidite systems, Tanqua Karoo, South Africa: Sedimentology, v. 48, p. 987–1023, doi: 10.1046/j.1365-3091.2001.00405.x.

Kingsley, C.S., 1981, A composite submarine fan-delta-fluvial model for the Ecca and lower Beaufort Groups of Permian age in the Eastern Cape Province, South Africa: Transactions—Geological Society of South Africa, v. 84, p. 27–40.

Marchant, J.W., 1978, The metal contents of organic separates of some Ecca shales: Transactions—Geological Society of South Africa, v. 81, p. 173–178.

McLachlan, I.R., 1973, Problematic microfossils from the lower Karroo beds in South Africa: Palaeontologia Africana, v. 15, p. 1–21.

McLachlan, I.R., and Anderson, A., 1973, A review of the evidence for marine conditions in southern Africa during Dwyka times: Palaeontologia Africana, v. 15, p. 38–64.

Miller, K.G., Kominz, M.A., Browning, J.V., Wright, J.D., Mountain, G.S., Katz, M.E., Sugarman, P.J., Cramer, B.S., Christie-Blick, N., and Pekar, S.F., 2005, The Phanerozoic record of global sea-level change: Science, v. 310, p. 1293–1298, doi: 10.1126/science.1116412.

Pemberton, S.G., Spila, M., Pulham, A.J., Saunders, T., MacEachern, J.A., Robbins, D., and Sinclair, I.K., 2001, Ichnology and sedimentology of shallow to marginal marine systems: Geological Association of Canada Short Course Notes 15, 343 p.

Tankard, A.J., Jackson, M.P.A., Eriksson, K.A., Hobday, D.K., Hunter, D.R., and Minter, W.E.L., 1982, Crustal evolution of southern Africa: New York, Springer-Verlag, 523 p.

Veevers, J.J., Cole, D.I., and Cowan, E.J., 1994, Southern Africa: Karoo Basin and Cape Fold Belt, *in* Veevers, J.J., and Powell C.McA., eds., Permian-Triassic Pangean basins and foldbelts along the Panthalassan margin of Gondwanaland: Geological Society of America Memoir 184, p. 223–279.

Visser, J.N.J., 1989, The Permo-Carboniferous Dwyka Formation of southern Africa: Deposition by a predominantly subpolar marine ice sheet: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 70, p. 377–391, doi: 10.1016/0031-0182(89)90115-6.