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Paleosols of the Chuar group by Gregory J. Retallack,

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Timing and logistics. This field work was initially approved in 2018, but early snow during that season forced postponement for a year. It was undertaken from September 16-20, 2019 with a party of four (Greg Retallack, Adrian Broz, Larry Lai and Kevin Gardner: all Earth Sciences, University of Oregon). We walked down the Nankoweap Trail to camp in Nankoweap Creek (Fig. 1), and found paleosols at two levels in the Chuar Group, returning 30 lbs of 29 rock specimens to the University of Oregon for ongoing consumptive analysis.



Fig. 1 Approaching Nankoweap Creek camp, with Chuar group in background.

Scientific results: The aim of finding and sampling paleosols in the Neoproterozoic Chuar Group in Nankoweap Creek, Grand Canyon National Park, was achieved. Six paleosols were characterized and sampled in the Tanner Member of the Galeros Formation at N36.29424 W111.902146 (770 Ma), and four paleosols characterized and sampled in the Carbon Butte Member of the Galeros Formation at N36.279415 W111.890239 (760 Ma: Fig. 2). These were in the eroded badlands of the Nankoweap Trail and in a creekside bluff respectively, so that minimal excavation was need to secure rock specimens. These were the principal paleosol horizons seen, because much of the sequence appears marine or lacustrine. Chemical analyses

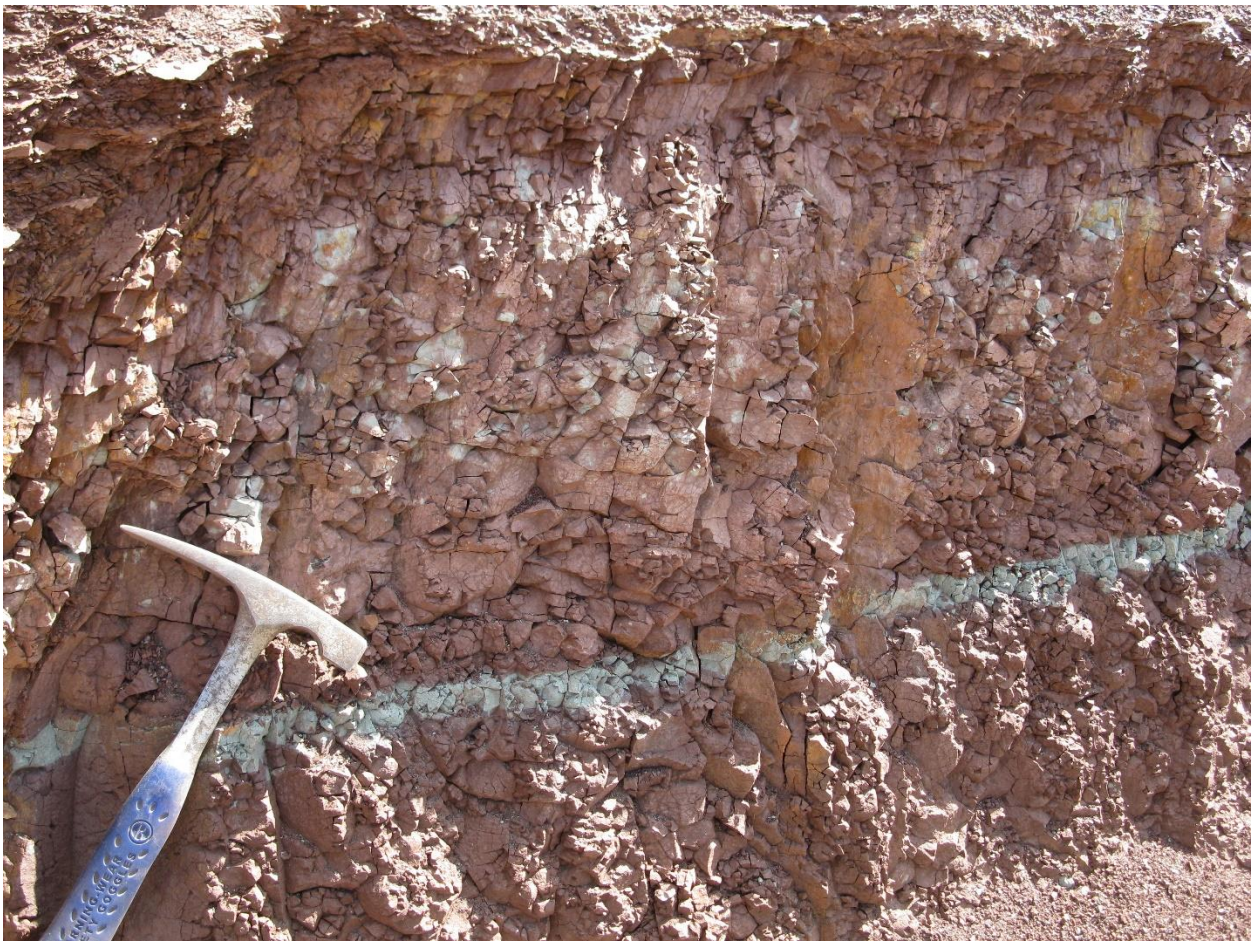


Fig. 2. Calcic paleosol in the Carbon Butte Member of the Galeros Formation in Nankoweap Creek, Grand Canyon, Arizona.

and thin sections for petrographic analysis are being prepared to evaluate the paleoenvironmental significance of the paleosols.

Scientific significance: Although much current environmental research is on global warming, it may be more instructive to study cooling in the past, such as Snowball Earth, a time 720-635 million years ago when ice caps extended to low latitudes. Increased weathering and novel carbon-consuming life forms are the two leading theories for onset of Snowball Earth. Both were be addressed by study of fossil soils in the Chuar group along the Nankoweap Creek in the Grand Canyon. The hypothesis to be tested was that global glacial advances of Snowball Earth were created by chemical weathering accelerated by evolutionary advances in terrestrial biota.

Much needs to be done, but the hypothesis looks promising because the paleosols discovered in Nankoweap Creek are thick and deeply weathered like geologically younger paleosols (Fig. 3), and much more deeply weathered than geologically older paleosols (Fig. 4). Thus there was a notable increase in depth and degree of weathering before Snowball Earth, followed by a decline in weathering after Snowball Earth as a part of the mechanism to escape such widespread glaciation. These field observations will be supplemented by a quantitative assessment of the mineral and chamical weathering of the paleosols for comparison with other paleosols of the Neoproterozoic.

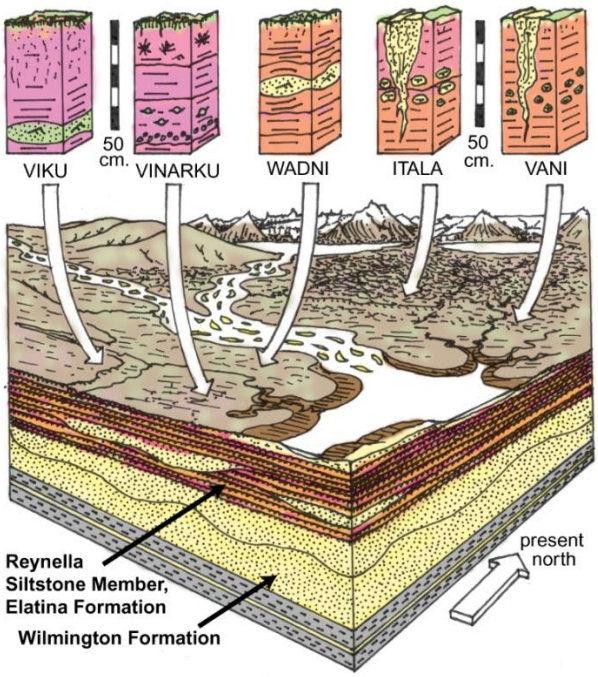


Fig. 3. Reconstructed soils and paleoenvironment of the Reynella Siltstone Member of the Elatina Formation of Cryogenian age (700 Ma) near Hallett Cove, South Australia (from Retallack et al., 2015, Precambrian Research 263:1-18.).

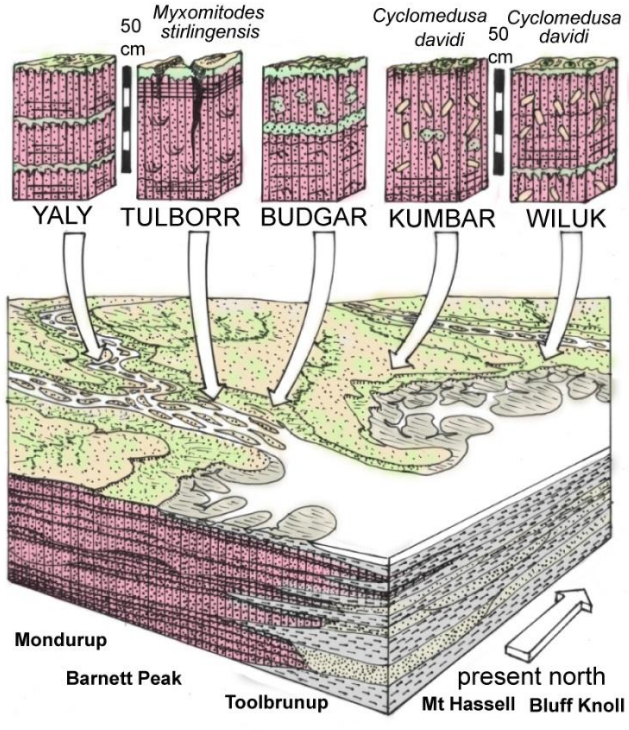


Fig. 4. Reconstructed soils and paleoenvironment of the Stirling Range Sandstone of Paleoproterozoic age (1900 Ma) in the Stirling range of Western Australia (from Retallack and Mao 2019, Palaeogeography Palaeoclimatology Paleoecology 532:100266).