



## Reply to comment by K. Sugitani et al. (2016) on the article “Archean coastal plain paleosols and life on land” by G.J. Retallack et al. (2016), *Gondwana Research* 40, 1–20.



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Detailed comments by Sugitani et al. (in press) on our recent paper (Retallack et al., 2016) are especially welcome at this time because they betray fundamental misunderstanding of alluvial paleosols, and thus may explain why it took so long to recognize them simultaneously in both South Africa (Nabhan et al., 2016) and Western Australia (Retallack et al., 2016). Their account emphasizes depositional environments, but such environments commonly include soils, such as sand flats (Psamment soils), clay pans (Fluvent soils) and salt crusts (Gypsid soils: Retallack, 2001). Our inclusion of a soil science perspective complements, but in no way negates, the view of Sugitani et al. (in press), who “suggested that the cherts were deposited in a coastal, closed to semi-closed basin where marine water could have been mixed with continental run-off and/or low temperature hydrothermal fluids.” Soils form by modification of sediments in place, and so furnish additional site-specific paleoenvironmental information not obtainable from sedimentology alone. There is not space to renegotiate all the lines of evidence for paleosols in the Farrel Quartzite, but perhaps this list will suffice: sharp top to massive beds grading down to laminated and ripple marked beds, vertical and horizontal crack systems, nahcolite and barite sand crystals up to 2 cm long, surficial depletion of weatherable feldspar and rock fragments, negative strain and mass transfer of elemental distribution, and microfossils more abundant near the tops of the profiles. Our paper also devoted 63 lines to distinguishing paleosol features from alternatives such as burial diagenesis and metamorphism. For a more detailed account of the various lines of evidence for recognition of Precambrian paleosols, see Retallack (2016a).

Clarification that the “type locality” of Sugitani et al. (2007) is different from ours is also welcome, and the geographic coordinates of our site can be confirmed as accurate, as taken in the field with a 12-channel GPS unit and later confirmed by landmarks on Google Earth. The original intention of our study was to find the “type locality”, but that was difficult using the inadequate map and sections of Sugitani et al. (2007). This turned out to be a blessing because the section we studied looked more like the idealized section with its thick beds (Fig. 3 of Sugitani et al. in press), than the pictures (Fig. 2 of Sugitani et al., in

press), which show a less paleoenvironmentally informative sequence of thin Jurnpa paleosols (of Retallack et al., 2016).

Also notable is emphasis by Sugitani et al. (in press, fig. 5) on the symmetrical form (discoids) of the “spindle” microfossils, whereas we found asymmetric forms (spindles) more common, as did Sugitani et al. (2007), who measured 184 asymmetric and only 41 symmetric. Our interpretations of biological affinities used only the two references cited and data tabulated in our paper: the 5 morphs established by Sugitani et al. (2011), and photographs of the specimens whose carbon isotopic composition was analyzed by House et al. (2013). We reported no new morphological or biochemical data, and our taxonomic form genera were limited to names already published. There is a pressing need for a detailed taxonomic account of these microfossils, many of them better assigned to new species and genera based on the especially well characterized material of Sugitani et al. (2007, 2011).

The discovery of acid-sulfate alluvial paleosols simultaneously in South Africa (Nabhan et al., 2016), Western Australia (Retallack et al., 2016), and on Mars (Retallack, 2014) is an exciting new development for astropedology (Retallack, 2016b). Another stunning new development is the use of Ge/Si ratios to distinguish marine-lacustrine versus non-marine pedogenic Precambrian cherts (Tarhan et al., 2016; Retallack, in press). This and other tests of the paleosol hypothesis for Farrel Quartzite beds are envisaged for the future, because our various geological and biological hypotheses deserve further testing. For the moment we agree with the overall assessment of Sugitani et al. (in press): “we do not exclude the possibility that the Farrel Quartzite could contain paleosol horizons”. Our interpretation is novel, perhaps even startling, but remains unfalsified.

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