fossilised raindrops

First find of fossilized raindrop imprints in the Moodies Group (3.2 Ga), Barberton Greenstone Belt, South Africa

During a geological excursion following a recent International Continental Drilling Project (ICDP) field workshop near Barberton, the world's oldest raindrop imprints were discovered. While attending the field trip led by Dr. Martin Homann to the so-called "Laura's Delta" of the Moodies Group on Oct. 10th, Tyler Robinson, a local geologist, came across a particular sandstone slab. Mudcracked shale topping that slab revealed upon closer examination several circular and elongate depressions 2-3 mm in diameter which were identified by Wlady Altermann as fossilized raindrop imprints, to which all field trip participants agreed.

Altermann's interpretation was strengthened by Dr. Stefan Lalonde, finding nearby another shale-coated sandstone slab with desiccation cracks developed in mud pools between symmetrical ripple troughs, but without raindrop imprints. These two loose slabs and the sedimentary structures in the over- and underlying sandstones support the overall facies interpretation of a prograding delta sequence from this unit, described by Laura Stutenbecker in her 2014 Master thesis at the Freie Universität Berlin. An interbedded tuff has been dated at 3229 ± 15 Ma (Stutenbecker, 2014). These fossil raindrop imprints are thus to-date the world's oldest evidence of atmospheric precipitation and make yet another superlative from the geology of the Barberton-Makhonjwa Mountains.

To fossilize raindrop imprints requires special conditions. A brief shower on fine-grained volcanic ash, rapidly covered by subsequent ash and quick lithification is ideal, otherwise the subtle craters will desiccate and disintegrate. Raindrop imprints are known from terrestrial deposits throughout Earth history. South Africa probably has the best geological record of very old raindrop imprints in the world. Aside from the well-known raindrop imprints first described by van der Westhuizen et al. (1989), Altermann and Lenhardt (2012) and Som et al. (2012), from

Photographs of the sandstone slab with mudcracks and some of the raindrop imprints found in the Moodies Group, Barberton Greenstone Belt (taken by Tyler Robinson)

the ca. 2.78 Ga T'Kuip section of the Ventersdorp Supergroup, raindrop imprints were also documented by Altermann and Robinson in former lacustrine strata of the Hekpoort Formation (about 2.22 Ga) during BSc Hons mapping (unpublished). In the strata of the Pongola Supergroup, ca. 2.9 billion years old, some raindrop imprints are also preserved (N. Hicks and A. Green, pers. communication).

Why are fossil raindrop imprints important? To begin with, they document the existence of an atmosphere and of a hydrological cycle, that is, of evaporation, transport of water vapor in the atmosphere and subsequent precipitation as water droplets over land, followed by runoff in streams back into the oceans. Although calculations to reconstruct the Archean atmospheric density using crater size by Som et al. (2012) appear unreliable (Kavanagh and Goldblatt, 2015), the terminal fall velocity of the largest raindrops is a function of air density and gravity. In the present-day atmosphere, the largest raindrops measure c. 7 to 10 mm in diameter and their fall velocity is ca. 9.3 m per second. Raindrops cannot fall faster or grow larger because they would break up into smaller droplets; however, they can be significantly accelerated by downward-oriented storm gusts etc. Thus, a large data set of raindrop imprints from different depositional settings over the immense Precambrian time span could conceivably contribute to a better understanding of atmospheric evolution (Cassata and Renne, 2012; van Kranendonk et al., 2015).

Photographs of the sandstone slab with mudcracks and some of the raindrop imprints found in the Moodies Group, Barberton Greenstone Belt (taken by Tyler Robinson)

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