Isua, "golden spikes" and the lack of zircons: Constraining the earliest volcano-sedimentary record

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There is an understandable desire and need to have the oldest parts (>3600 Ma) of Earth's volcano-sedimentary record dated and understood via a series of "golden spikes" to the same degree as for the Phanerozoic - for the same reasons of charting evolution of life, the hydrosphere and atmosphere. Indeed, the scope of modern zircon dating technologies means it should be possible to obtain accurate dates, and with the will and resources (=$$), to have precisions of only 1 million years or even less attached to them.

Instead, the problem in defining the most ancient volcanic and sedimentary timescale comes from the rock record itself via (1) its tectonothermal complexity (all rocks are amphibolite-granulite facies tectonites), (2) the rarity of volcano-sedimentary rocks bearing zircons that give the actual time of deposition and (3) dispute over the protoliths (volcanic or intrusive) of some zircon-bearing rocks.

In the 1980s mapping of the Isua belt suggested that it contained one or two sequences, disrupted by early tectonic breaks (Nutman et al., 1984), and there was a broad acceptance that the then available zircon dates of 3800 Ma (Michard Vitrac et al., 1977; Baadsgaard et al., 1984; Compston et al., 1986) on a single outcrop of a single unit interpreted to be a felsic volcanic could be taken as the age of the whole belt. Since then, this 1980s "golden spike" has been thrown into doubt by questioning whether the dated unit is a volcanic or (altered) intrusion. (e.g., Myers, 2001).

New zircon dating in the 1990s showed that the belt contains ca. 3710 and >3790 Ma volcano-sedimentary rocks (Nutman et al., 1996, 1997, 2002), and new field studies by different groups have all concluded that the belt is partitioned by early (3600 Ma?) tectonic breaks - although there is yet to be consensus as to the details of the tectonic architecture (Nutman et al., 1997, 2002; Komiya, 1999; Appel et al., 1998). These new findings mean that there is a need for more zircon dating to define the age of the Isua rocks - yet suitable units are hard to come by - given the predominance of amphibolites derived from pillow basalts.

Presently the unit with the most robust, accurate date are some graded felsic volcanic rocks in the eastern end of the belt - which yields only 3710 Ma zircons (Nutman et al., 1996, 1997, 2002; B. Kamber pers comm., 2004). These are the present best candidate for "golden spike" status in the earliest timescale. Rocks with potential "golden spike" staus are cherts and banded iron formations in the east of the belt which yield small amounts of 3700 Ma zircon that we interpret to be from small input of airborne volcanic material (Nutman et al., 2002). This still leaves most of the earliest volcano-sedimentary record dominated by amphiboluites from Isua and elsewhere without accurate dates. Instead, tonalite dykes that intrude them provide a minimum age. Thus amphibolites in the southern part of the belt are intruded by ca. 3790 Ma tonalities (Nutman et al., 1996, 1997, 2002; Crowley et al., 2002) and must be at least 80 million years older than the felsic volcanic 3710 Ma "golden spike" candidates in the east of the belt.