1-1-2007

Comment on "A Vestige of Earth's Oldest Ophiolite"

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Keywords

ophiolite, oldest, earth, vestige, comment, GeoQUEST

Disciplines

Life Sciences | Physical Sciences and Mathematics | Social and Behavioral Sciences

Publication Details

Nutman, A. P. & Friend, C. R. L. (2007). Comment on "A Vestige of Earth's Oldest Ophiolite". Science, 318 (5851), 746c-746c.

Technical comment on: A Vestige of Earth's Oldest Ophiolite

Geochemical evidence already demonstrates that the Isua supracrustal belt contains island arc assemblages formed at convergent plate boundaries (1,2). A complete ophiolite assemblage in Isua including "sheeted dikes" proposed by Furnes et al. (3), would strengthen this conclusion. Regrettably, Furnes et al. (3) did not alert their readers to the fact that the Isua supracrustal belt contains supracrustal rocks and mafic dikes of different ages (4,5), and thereby have not demonstrated that the components identified for their ophiolite are *coeval*. This is important because genuine ophiolites are a *coeval* assemblage of gabbros, sheeted dikes and pillow lavas (e.g., 6).

Sheeted dikes?

At Isua, the copious Paleoarchean Ameralik dyke swarms cut all Eoarchean rocks, including all components of the 3.81-3.63 Ga orthogneisses (Fig. 1) that envelope the Isua supracrustal belt (7). Within the Isua supracrustal belt, the Ameralik dykes are variably deformed and largely recrystallized into amphibolites (8). Remarkably, Furnes et al. (3) did not even mention that these dikes exist when discussing the origin of their "sheeted dikes". In the area covering Furnes et al.'s localities 2 and 3, detailed mapping (Fig. 2) shows that there are numerous amphibolite dikes of differing thickness that are aligned subconcordantly to the lithological layering of the host volcano-sedimentary rocks. Dikes occur not only in the metavolcanic amphibolites as described by Furnes et al. (3), but also in siliceous metasediments, ultramafic rocks, and the petrogenetically unrelated "boninitic" amphibolites to the west. As these dikes cut a wide range of unrelated lithologies, they cannot all represent a simple "sheeted dike" complex as proposed (3). Furthermore, in geochemical diagrams (Fig. 3 of Furnes et al.), the data presented show that their dikes are less evolved than the material they are supposed to feed. This in contrary to the suggestion that the pillows and sheeted dikes are related. Thus, Furnes et al.(3) need to show that they have distinguished dikes that are younger, unrelated intrusions such as (≤3.5 Ga) Ameralik dykes and ones that might really form an earlier sheeted complex.

Structural relationships

Furnes et al. (3) state that, traversing northwards from their localities (3) to (1), entails passing stratigraphically upwards from “sheeted dikes” to pillows (their Fig. 2A). Thus, pillows at their locality (1) should be facing *northwards*. Our photograph of the same pillows (Fig. 3) shows that they actually face *southwards*, opposite to the sense that is required for their proposed simple stratigraphic relationship. Therefore the structural relationships cannot be as simple as they suggested.

Age of rocks

Furnes et al. did not inform their readers that the Isua supracrustal belt contains fragments of both 3.7 and 3.8 Ga volcano-sedimentary sequences (4,9). Thus, the metachert unit that crops out beside their localities 1 to 3 (Figs. 1 and 2) contains rare ca. 3.7 Ga volcano-sedimentary zircons (9), suggesting the *maximum* age of this package. On the other hand, in the southwest of the belt where Furnes et al. (3) proposed there are coeval ophiolitic gabbroic protoliths, amphibolites there are cut by ca. 3.8 Ga tonalite sheets, giving their *minimum* age (4,9,10). Have Furnes et al. equated ca. 3.8 Ga metagabbros with ca. 3.7 Ga metavolcanic rocks and maybe some still younger dikes? More exacting evidence is required to turn “Earth’s oldest ophiolite” from an exciting proposition into an established fact.

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REFERENCES

(1) A. Polat, A.W. Hofmann, *Precambrian Research* **126**, 197 (2003).

(2) F.J. Jenner, V.C. Bennett, A.P. Nutman, 2006 *Goldschmidt conference abstracts*, (2006).

(3) H. Furnes, M. de Wit, H. Staudigel, M. Rosing, K. Muehlenbachs, *Science*, **315**, 1704 (2007).

(4) A.P. Nutman, V.C. Bennett, C.R.L. Friend, M.T. Rosing, *Chemical Geology* **141**, 271 (1997).

(5) A.P. Nutman, C.R.L. Friend, C.R.L., V.C. Bennett, Journal of the Geological Society of London. **161**, 421 (2004).

(6) J.W. Shervais, *Geochemistry Geophysics Geosystems* **2**, paper 2000GC000080 (2001)

(7) J.H. Allaart, J.H., in ***The Early History of the Earth***, B.F. Windley Ed. (Wiley, London, 1976) pp. 177-189.

(8) A.P. Nutman, *Bull. Grønl. Unders.* 154, 88 pp. (1986).

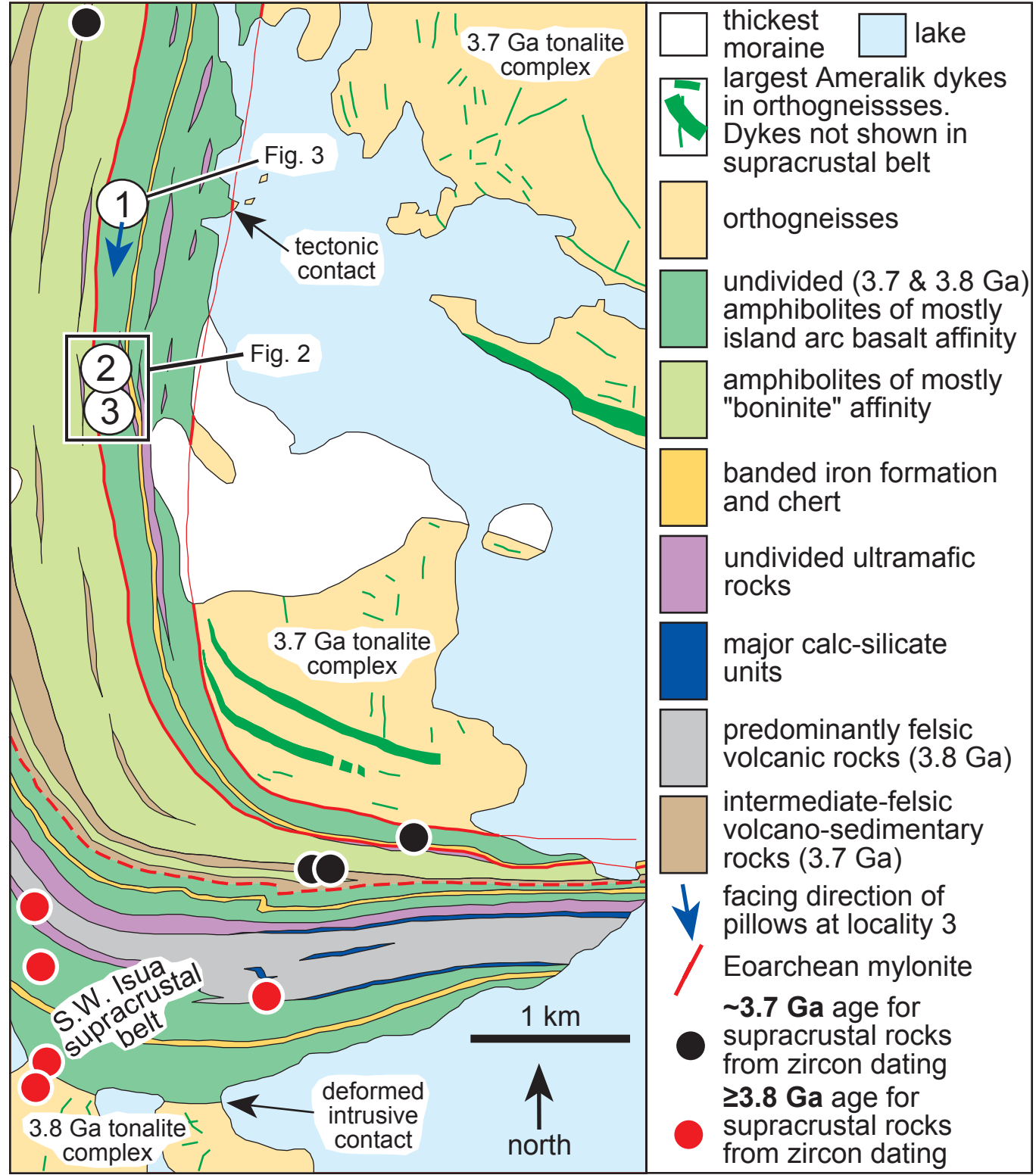
(9) A.P. Nutman, C.R.L., Friend, V.C. Bennett, *Tectonics*, **21**, article 5 (2002).

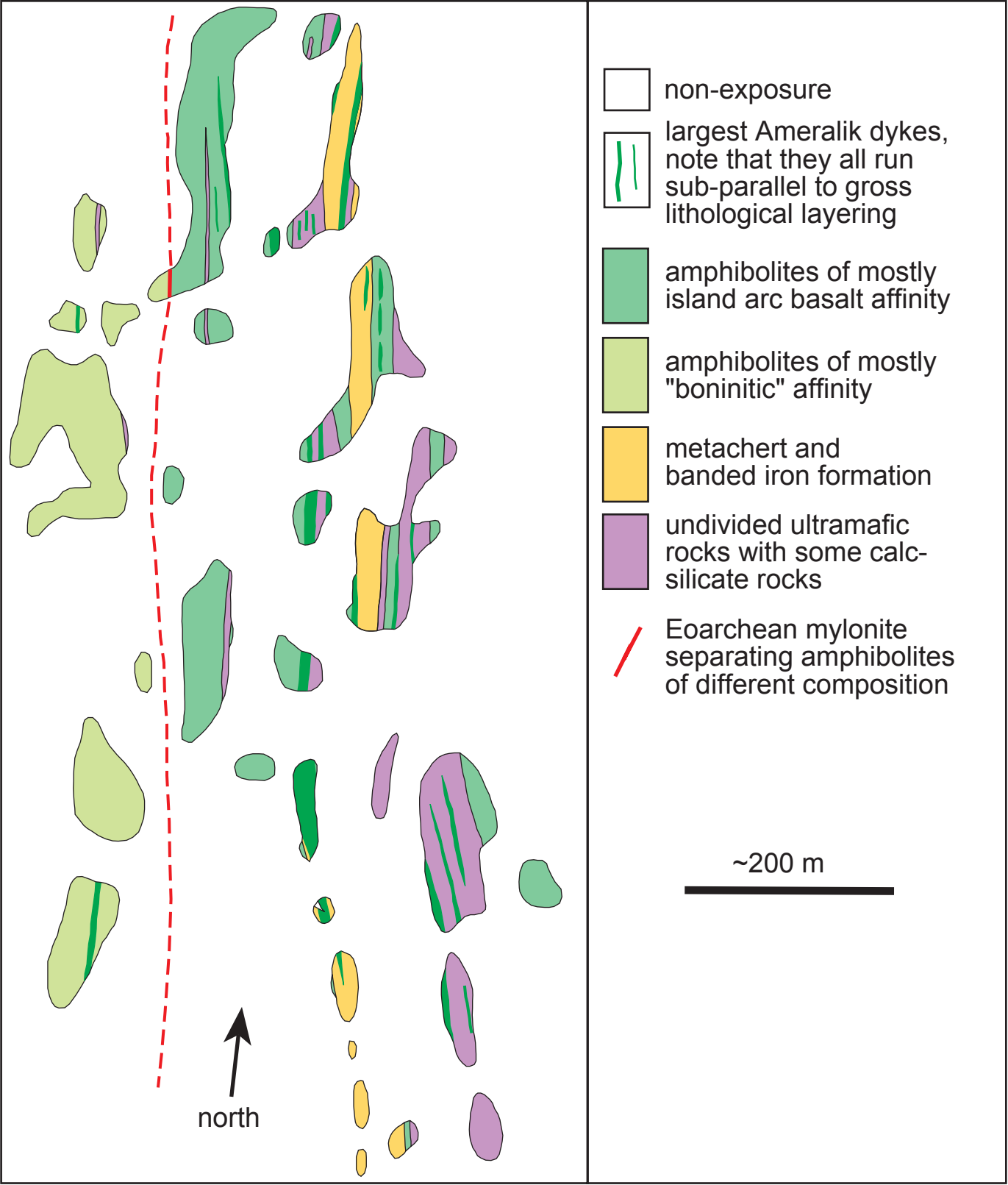
(10) J.L. Crowley, *Precambrian Research* **126**, 235 (2003).

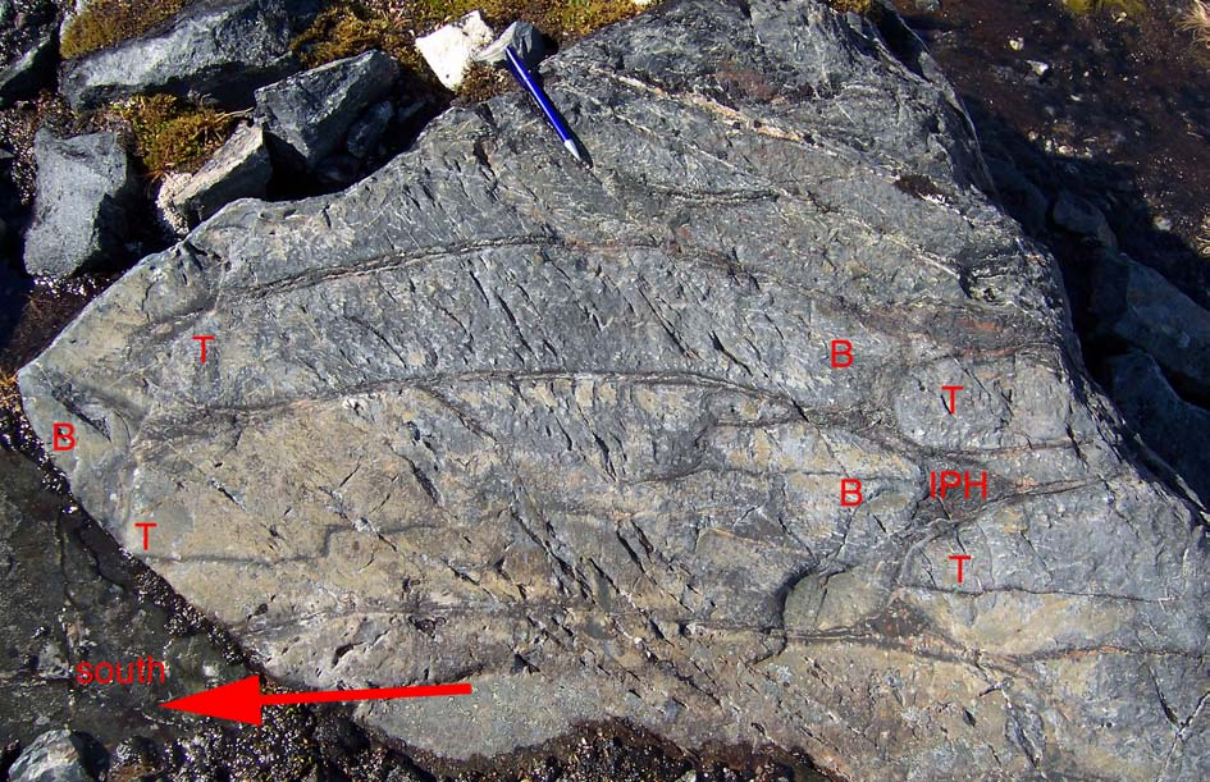
Fig. 1. Geological sketch map of part of the western end of the Isua supracrustal belt. Only the thickest, most continuous areas of cover moraine are shown. Mapping compiled from sources (8,9). Zircon dating results constraining the ages of supracrustal rocks in the southwest to ≥3.8 Ga and in the northeast to ≤3.7 Ga are shown. The localities 1, 2 and 3 are from Furnes et al. (3). Note the partitioning of the belt by Eoarchaean shear zones. The likely position of the break between the ca. 3.8 and 3.7 Ga sequences is presently known only within 200 m (9).

Fig. 2. Ca. 1:10,000 scale mapping by A.P. Nutman in August 1980 of the area thought to cover the Furness et al. (3) localities 2 and 3, by using their low resolution sketch map (Fig. 1C). Note that numerous amphibolitized dikes cut all lithologies and are orientated subconcordant to the lithological layering.

Figure 3. Pillow lavas at the Furnes et al. locality 1. Note the shape of the pillows indicates facing to the south (left of picture), and hence *towards* the proposed sheeted dikes. IPH is the interpillow hyaloclastite shown by Furnes et al., T and B are the top and base respectively of some pillows (photo by A. P. Nutman). The pillows have been flattened orthogonal to their original orientation


3.7 Ga tonalite complex
Fig. 3
1
tectonic contact
Fig. 2
2
3
3.7 Ga tonalite complex
S.W. Isua supracrustal belt
1 km
north
deformed intrusive contact
3.8 Ga tonalite complex
thickest moraine
lake
largest Ameralik dykes in orthogneissses. Dykes not shown in supracrustal belt
orthogneisses
undivided (3.7 & 3.8 Ga) amphibolites of mostly island arc basalt affinity
amphibolites of mostly "boninite" affinity
banded iron formation and chert
undivided ultramafic rocks
major calc-silicate units
predominantly felsic volcanic rocks (3.8 Ga)
intermediate-felsic volcano-sedimentary rocks (3.7 Ga)
facing direction of pillows at locality 3
Eoarchean mylonite
~3.7 Ga age for supracrustal rocks from zircon dating
≥3.8 Ga age for supracrustal rocks from zircon dating


non-exposure
largest Ameralik dykes, note that they all run sub-parallel to gross lithological layering
amphibolites of mostly island arc basalt affinity
amphibolites of mostly "boninitic" affinity
metachert and banded iron formation
undivided ultramafic rocks with some calc-silicate rocks
Eoarchean mylonite separating amphibolites of different composition
~200 m
north


T
B
T
B
T
B
IPH
T
south