Eoarchean formation of the Isua supracrustal belt

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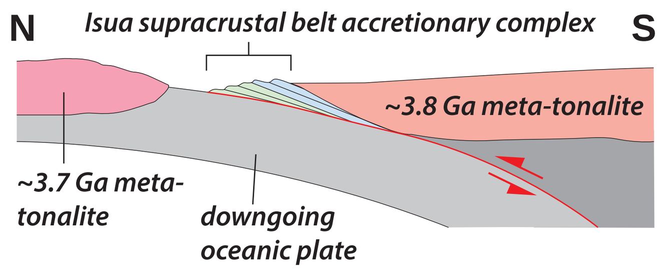
A major shift in Earth's crustal generation processes is increasingly inferred at ~3.2 to 2.5 Ga. The most commonly-invoked hypothesis to explain this shift is the onset of plate tectonics.

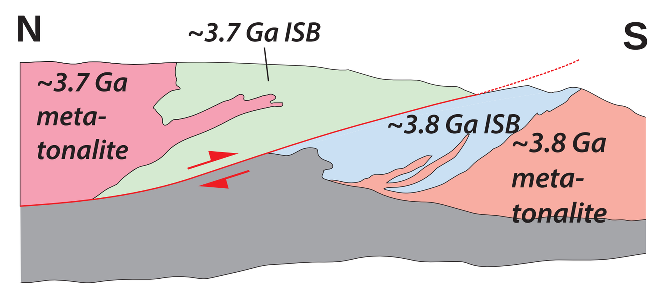
Formation of an accretionary complex (c. 3.8 - 3.66 Ga)



Arai et al. 2015 Tectonophysics

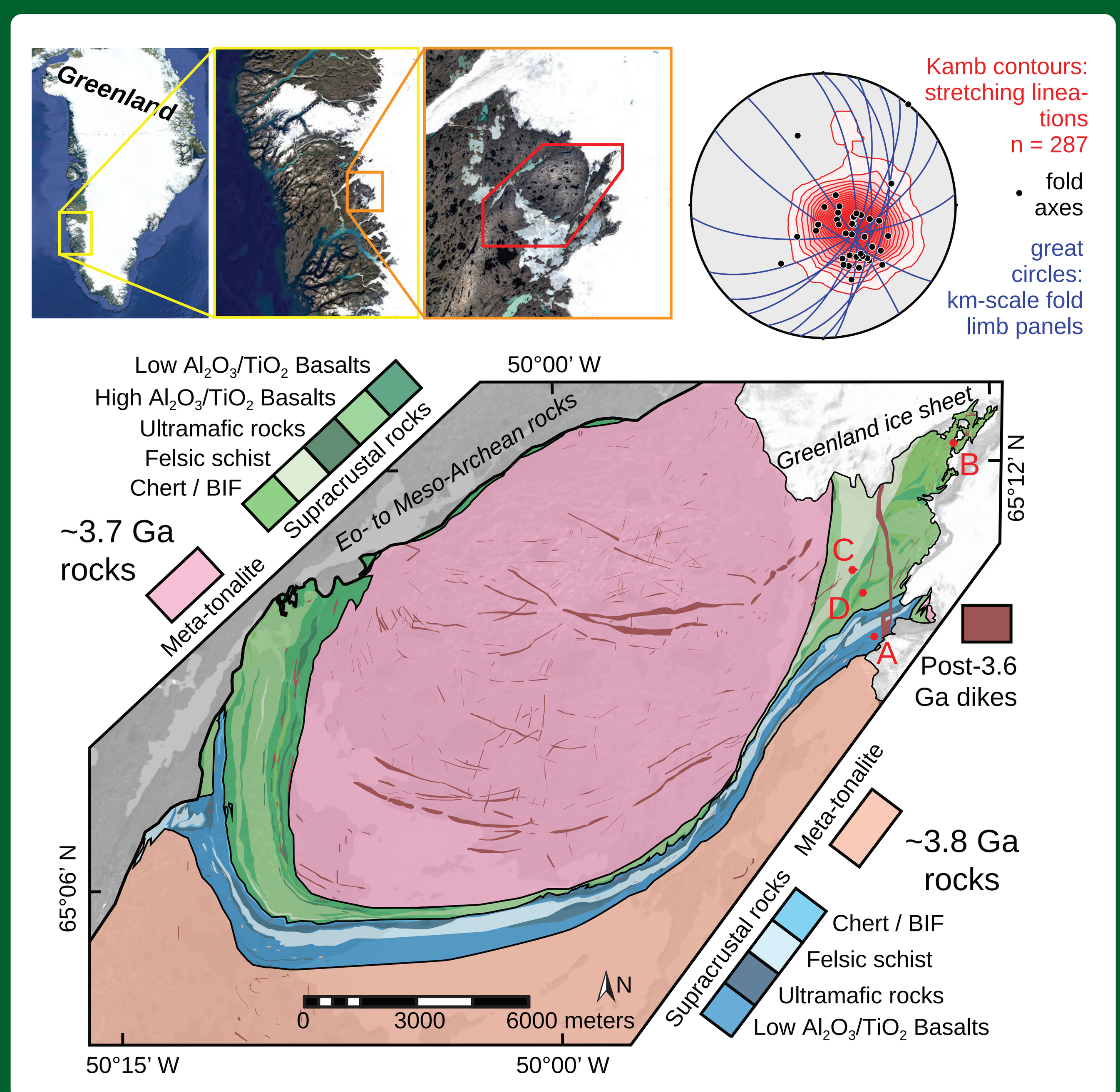
Prior detailed geologic studies of the ~3.85 - 3.60 Ga Isua supracrustal belt (SW Greenland) interpret this site to record plate tectonic terrane collision.

Collision of northern and southern terranes (3.69 - 3.66 Ga)

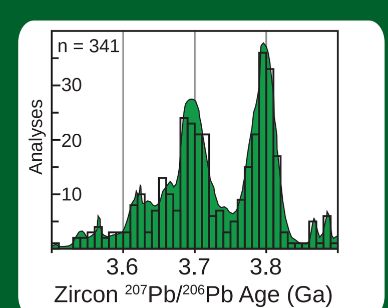


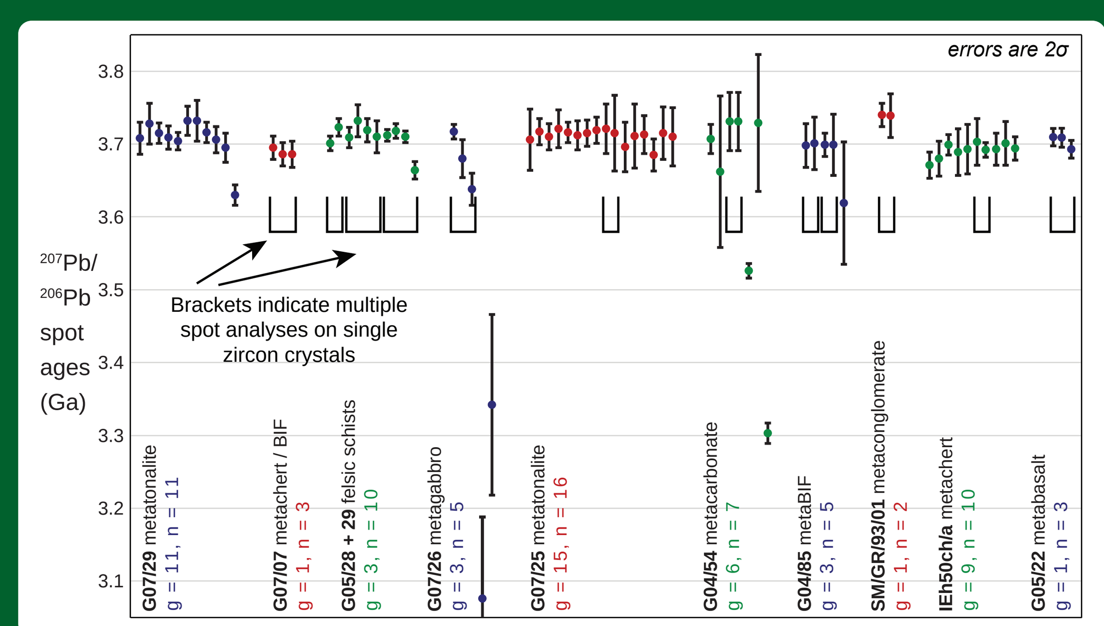
Nutman and Friend 2009 Precambrian Research

Location, schematic geologic map (modified from Nutman and Friend, 2009), and stereoplot showing key aspects of the Isua supracrustal belt. Red lettered positions on the map correspond to photograph locations (see lower right of poster). BIF—banded iron formation.

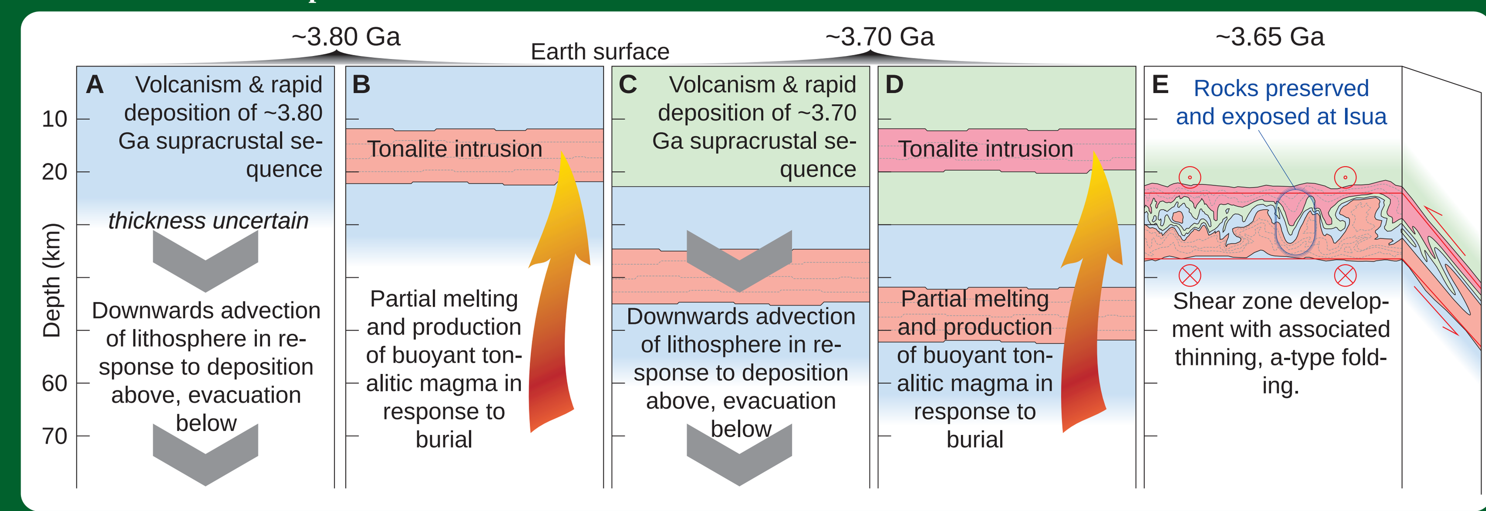


Geochronological data have previously been interpreted to record as many as eight tectonic events. The division of the belt into ~3.8 Ga and ~3.7 Ga components is robust (see histogram from Nutman et al., 2013, below left). However, key data are too sparse to uniquely interpret proposed ~10^7 year age differences between samples (see below, details in Webb et al., 2020).





Webb et al. 2020 Lithosphere



We propose that the development of the belt is most simply explained by vertical-stacking volcanic and instrusive processes followed by a single shearing event.

Our findings are consistent with nonuniformitarian origins for the Isua supracrustal belt.

REFERENCES CITED

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Komiya et al., 1999, The Journal of Geology, v. 107, no. 5, p. 515–554.
Nutman and Friend, 2009, Precambrian Research, v. 172, no. 3–4, p. 189–211.
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Photographs showing key metamorphic and structural characteristics of the Isua supracrustal belt.

(A) Metamorphosed and strained pillow lavas do not preserve significantly lower strain versus the bulk of the belt; the same penetrative lineation pervades the belt. View (i) looks down the lineation direction, with dark ellipses marking the metamorphosed rims of pillows (6 in. [15 cm] red-tinted ruler for scale). View (ii) looks perpendicular to the foliation and lineation (6 in. [15 cm] red-tinted ruler for scale, in the same location as in part i.). Annotated inset (iii) highlights the lineation visible in (ii). (B) Garnet-bearing mafic schists occur in the far northeastern part of the Isua supracrustal belt, demonstrating that amphibolite-facies prograde conditions were experienced by the entire belt (hand lens for scale). Red garnets occur in layers in the left and right thirds of the image. (C) Chlorite crosscutting biotite in garnet-bearing mafic schists of the northeastern Isua supracrustal belt, indicating retrogression. (D) Key fault, fold, and stretching fabric patterns occur at the dark hill in upper photograph (i). Photos (ii) and (iii) show two faults. In (ii), the classic example from Komiya et al. (1999, their Figure 2) is shown in a somewhat larger view, including additional complex folding to the lower right. In (iii), termination of chert-pebble meta-conglomerate layers reveals another fault surface. Photos (iv) and (v) reveal that although the meta-conglomerate appears to have largely escaped deformation when viewed parallel to the lineation (iv), the lineation-perpendicular view (afforded by prior dynamite blasting, v) reveals that these rocks do not preserve significantly lower strain versus the bulk of the belt. We interpret the deformation observed here within the context of sheath and curtain folds which include relatively minor tearing of layers.