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Solid Earth
Discussions

Interactive comment on "The rheological behavior of fracture-filling cherts: example of Barite Valley dikes, Barberton Greenstone Belt, South Africa" *by* M. Ledevin et al.

A. Hofmann (Referee)

hofmannaxel@hotmail.com

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General comments The article by Ledevin et al on the rheological behavior of fracture-filling cherts from an area in the Barberton greenstone belt sheds some new light on the debated origin of chert veins that are important for the understanding of surface processes and early life in the Palaeoarchaean record. According to the authors the most important finding of the study centers on the physical characteristics of the fluid that filled the fractures – the thixotropic behavior. While I generally concur with this interpretation, this is not a new idea and has been mentioned in the literature before (e.g. de Vries et al., 2010), although a careful analysis has not yet been undertaken.

The current work thus aims to fill the gap, but the evidence presented is sparse and, to some extent, weak. For example, matrix-support of clasts in dykes is regarded as evidence that blocks were not able to settle downward. However, most dykes are filled with an interlocking framework of clasts that could not have moved much. In addition, not everything that appears black in the veins represents matrix. In fact, looking closely at Fig. 7d ("a typical example of a matrix-supported dike") reveals partial marginal or complete replacement of host rock fragments to massive black, translucent chert, similar to the particles labelled as black chert. This means that the amount of host rock fragments is actually larger, but not always easy to spot, and that some matrix-supported dykes may actually be clast-supported, especially when viewed in three dimensions. Hofmann and Bolhar (2007) and Lowe (2013) described various features from their studies of the chert veins. These include, for example, late-stage botryoidal chert/quartz fills and chert replacement by host rock fragments. How can these features be reconciled with the thixotropic behaviour? What was the temperature and water content of the slurry? A detailed discussion of these aspects is warranted, possibly aided by additional petrographic data. The authors regard the veins to reflect hydrothermalism related to meteorite impact, following the study of Lowe (2013) who describes impact spherule layers in the succession above. The authors however fail to acknowledge that chert veining is a ubiquitous phenomenon below Palaeoarchaean cherts in general (numerous examples from the Palaeoarchaean record of South Africa and Western Australia), interpreted by Hofmann and Bolhar (2007) to reflect conditions of the >3.0 Ga seafloor. While impacts may have locally triggered the escape of fluids due to seismic shaking, the general mechanism of vein formation cannot be attributed to impacts. The article is for the most part well written and well illustrated, although grammar and spelling mistakes pop up quite regularly and require some careful editing. However, more detailed evaluation of the cited literature should be done in order to clarify some of the points mentioned in the specific comments below. Major revision is recommended.

Specific comments p. 1229 l. 4-5: one cannot generalize that chert and BIF are common in greenstone belts and frequently occur as dikes – this is simply not true. Cherts are abundant in Palaeoarchaean belts where they also occur in the form of dikes (or veins rather). Chert is much less common in younger belts, where dikes are absent. BIF, in contrast, occurs throughout the Archaean record, but never occurs as dikes.

l. 21: the term oceanic crust should be replaced with something like sub-seafloor volcanic rocks

p. 1230 l. 9, replace is with consists of; oldest supracrustal rocks are 3.55, not 3.57 Ga; check recent paper by Kroener et al 2013

l.10, the BGB is not typical of Archaean but of Palaeoarchaean greenstone belts

l. 22, this is not true – there has also been a granitoid provenance, as exemplified for example by the presence of such clasts in the Moodies Group

p. 1231 l.14, the age of the tuff may be close to the time of the impact, but it does not date it

p. 1232

l.17, what do you mean by evolution of shapes? you may see different fracture geometries at different localities, but you probably do not see a dyke changing overall geometry as you follow it

1234 l. 2, why do you refer to the host rock as tuff? I assume the host rock here is part of the Mc1/Mc2 unit of Lowe (2013) which consists predominantly of different types of silicified sediment, now appearing as grey and black chert. Hofmann (2005), Hofmann and Bolhar (2007) and Hofmann et al (2013) concluded on the basis of trace element analysis that the cherts represent silicified fine-grained sediments very similar in chemical compositions to overlying Fig Tree shales and greywackes.

l.3, so where do the remaining 10% of clasts come from?

1237 l. 13-23, what about lateral flow? the same features could have been produced by such a flow.

1239 l.16-18, 27-29, somthing wrong with these sentences

l.21, what are these microstructures? explain.

1240 l.10, what is the evidence and mechanism of erosion of clay-sized particles – this has not been mentioned before

1241 l.4, the statement that "the abundance of silica" in the dykes suggest "a silica content comparable to the fluids used by Hunt et al. (2013)." is not based on any real data and requires to be constrained; the reference to Hunt et al is also missing

l.6, better constraing the evidence for fluid temperatures would be very important – the listed features that apparently provide evidence that the fluid temperatures were less than 200 deg C thus need proper discussion and evaluation

l. 8-11, this is speculation and I do not see what evidence there is from the field observations – if the fluid was transferred into gel within a day, then there would have been ample time for large fragments to settle down; also, what is the evidence that the gel was stable for months? Can you think of any features in the cherts that may suggest this?

1243 l. 2 the term "silicified cherts" needs rephrasing

l.6, I do not think that Lowe (2013) infers that the crater at the origin of the impact spherule bed S2 could be many hundreds of meters in width. Craters that may have given rise to the impact spherules were rather on the order of hundreds of kilometres assuming bolide sizes of several tens of km as indicated by Ir and Cr fluence.

1244 l.4, what is the evidence for syn-dike faulting or faulting associated with the chert veins? this has not been discussed; and then what is the reason to infer "frictionally generated amorphous silica"? this is unclear and seems to be pure speculation

l. 19-20, where is the evidence for "normal faults and mini-basins, the common occurrence of large dikes along these faults" etc? this needs to be described in the overall geological setting of the area

Fig. 2 would benefit from some dip/strike info

Fig. 3 caption has some spelling mistakes; why are the Mendon rocks referred to as volcaniclastics? b and c are not necessary as you show plenty of dykes later on

The term burst-out structure in Fig 6b is misleading as there is no evidence for something to have bursted from a point source. The veins show some sort of radial texture at this spot, but there are many vein orientations in those areas that are highly fractured that may here and there resemble a radial pattern – in fact, veins in Fig 6b also show a large variety of orientations.

The features shown in Fig. 8 (silica spheres) are not sufficiently discussed in the text. What is their origin and significance?

Fig. 10, remove "black chert dike" from photos and name the photos a to d, also indicate that these are photos in plane and crossed-polarized light, the same applies to Fig. 11

Interactive comment on Solid Earth Discuss., 6, 1227, 2014.