Rapid hydration and weakening of anhydrite under stress: Implications for natural hydration in the Earth's crust and mantle

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Reply to Reviewer Comments (RC2)

Comment from Author to Reviewer 2

We thank Reviewer 2 for their very positive comments. We believe that the comments and changes based on them have completed and improved the manuscript and we will certainly use the suggested advanced segmentation methods for future work.

Kind regards,

Johanna Heeb

on behalf of the authors

General comments and recommendation:

First comment on making a stronger link between crystallographic results and mechanical weakening:
Thank you for noticing this. The following sentences have been added to the section 4.2.3 where the crystallographic orientation of the newly formed gypsum is discussed:

Gypsum has a monoclinic crystal structure, where a bilayer of water molecules, stacked along the b axis, separates bilayers of Ca^{2+} cations and tetrahedral SO_4^{2-} anionic groups. The adjoining layers are linked through weak hydrogen bonding, making the plane containing the water molecules (010) the weakest plane of shear, and causing the perfect cleavage of gypsum (Wooster, 1936). The two secondary cleavages (100) and (011) have much higher ultimate shear strength than any shear directions measured on (010) (Williams, 1988). The pole plots show that there is a strong preferred orientation of the (010) planes of the gypsum crystals parallel to the predicted shear fracture angle in the analysed area (Fig. 5), further favouring slip along the veins. The crystals in the veins are larger, longer that the aperture of the veins, which makes CPO likely to be a growth phenomenon rather than a result of deformation of pre-existing natural gypsum.

Second comment on the location of sample collection and reproducibility of the study:
Thank you. The samples were collected by Enrique Gómez Rivas and Juan Diego Martín-Martín in the Igualada-Ódena area, where the Ódena gypsum member crops out along a line about 15 km long, trending NW-SW. It reaches a thickness of up to 30 m. The gypsum bed has three main terms: basal stromatolite, lower term and upper term. The lower term contains anhydrite masses up to several meters

long, more abundant in the lower half. The samples were collected form this part of the formation, north of the municipality of Ódena. A map with the location of the Ódena formation was added as supplement material (Fig. A20).

Additional comment on emphasizing the permeability more during discussion, in agreement with RC1:

Thank you. The rate of change we see is due to the microcracking, which is driven by the differential (non-hydrostatic) stress. There are multiple factors that then control the reaction rate, i.e., volume change, ongoing microcracking, etc., this is part of section 4.

Specific comments and replies

Line 99:
Agreed. The two suggested publications have been clearly missing and were added where suggested.

Line 145:
Thank you. A gypsum content of 10 to 15 % can be estimated for the original sample material, based on our data (included in the supplement material, Fig. A16, A17, A18, A19 and table A1).

Line 241:
Indeed, this is about a liquid.

Line 327:
Agreed. ‘Compaction’ has been replaced with ‘porosity’.

Line 380:
Thank you, this has been considered and addressed together with the corresponding comment of RC1.

Line 517:
Thank you. Lateral ‘cheeks/bulges’ has been replaced by ‘chips’.

Figure 7 captions:
Thank you. This figure has been adjusted accordingly.