Geophysical Research Abstracts
Vol. 13, EGU2011-3324, 2011
EGU General Assembly 2011

Is dehydration embrittlement at all important for generating intermediate to deep earthquakes in subduction zones?

Torgeir B. Andersen (1), Håkon O. Austrheim (1), Natalie Deseta (2), and Lewis D. Ashwal (2)

(1) University of Oslo, Department of Geosciences/PGP, Oslo, Norway (t.b.andersen@geo.uio.no), (2) University of Witwatersrand, Department of Geosciences, Johannesburg, South Africa

Prograde dehydration reactions causing embrittlement of subducting plates are a commonly used as a ‘textbook’ mechanism to explain intermediate to deep earthquakes in Wadati-Benioff zones. The reduction of effective stresses caused by fluids from metamorphic reactions and the accompanying increase of local fluid pressure can easily be argued. Therefore, the common and sometimes very large subduction earthquakes have logically been coupled with such fluid-releasing reactions. If, however, dehydration embrittlement is the dominant mechanism for earthquakes at depth in collision- and subduction zones, the co-seismic faults and the associated fault-rocks should provide the mineralogical and petrographic evidence for such embrittlement.

An increasing number of field-discoveries provide ‘hands-on’ examples of fossil seismic faults where the pseudotachylytes (PST) have quenched or devitrified at high confining-pressures documenting their deep origin. The most important examples are PSTs occurring in the Bergen Arcs, Lofoten and Western Gneiss Region of Norway, in Zambia, along the Woodroffe thrust in Australia, in the Cabo Ortegal area of NW Spain and the numerous examples of well preserved, but texturally and mineralogically complex PSTs developed in blueschist to lawsonite-eclogite facies rocks of Alpine Corsica. From available descriptions in the literature and our ‘first-hand’ experience with the Norwegian and Corsican examples it appears that there is a perhaps surprising lack of petrographic and mineralogical evidence for faulting that can be directly linked to dehydration reactions. With the exception of some samples where new olivine nucleates as coronas on serpentine in an ultramafic PST and where new pyroxene nucleates on talcified clasts of orthopyroxene in a gabbro PST; there are few examples where dehydration-reaction textures can be directly linked to the co-seismic faulting. Commonly, the mafic blueschist and eclogite facies PSTs have water-bearing quench-minerals. Blueschist PSTs from peridotite commonly crystallize water-free minerals (ol, cpx, opx) but often have a hydrous matrix and commonly vesicles along grain-boundaries. Hydrated wall-rock such as partially serpentinized peridotite with veins of serpentine and chlorite may produce PSTs with high water-content (up to 12% by volume) and vesicles. The texture with newly formed dry minerals in a water-bearing and locally vesicular matrix results from near complete melting of variably ‘wet’ wall-rock along a fault-strand and not because fluids were released by prograde metamorphic reactions before faulting took place. Our textural and mineralogical observations suggests that intermediate to deep earthquakes may be controlled by zones enriched by hydrous minerals, but these provided zones of ductile strain localization and associated weakening necessary for initiation the earthquakes, but not an increase in fluid-pressure by dehydration reactions