Solid Earth Discuss., 4, C65–C68, 2012
www.solid-earth-discuss.net/4/C65/2012/

Solid Earth
Discussions

Interactive comment on "High resolution reflection seismic profiling over the Tjellefonna fault in the Møre-Trøndelag Fault Complex, Norway" *by* E. Lundberg et al.

P. Ayarza (Referee)

puy@usal.es

Received and published: 9 March 2012

This work uses two high resolution seismic profiles shot across the Tjellefona Fault (TF) in order to infer the structure of this fault onland and at depth. They also use the data provided by 3 electric profiles acquired in the same area to support their interpretations.

The authors make a very good job with the processing of the seismic data, which appears, in the shot gathers, with a low s/n ratio. Travel time modelling comes up with the existence of SE dipping fracture zones that are associated to low velocity zones in the surface. They also identify P-S conversions which constrain the origin of the reflectivity, excluding the possibility that reflections might originate from lithological boundaries

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

with positive impedance contrasts (gneiss/amphibolites). Finally, their reflectors coincide with low resistivity zones making their interpretation very coherent.

General comments:

For me, the major problem is related to the implications of changing a NW dipping normal fault with km scale offsets from the last 100 Ma to a SE dipping fault. This would imply changing a normal fault by an inverse fault with km scale offsets and therefore changing the tectonic evolution of the area in the last 100 Ma. According to the authors, this fault has been active in different periods since the Devonian but never in a compressional tectonic setting. So if the authors want to challenge the previous interpretations, they should state it more clearly and give options for all the evidences that seem to indicate that the TF is a normal fault (I guess in addition to fission track data and topographic offsets, there is also a metamorphic offset). Otherwise, they should consider that what they see is not the TF but maybe conjugated faults associated to the TF (resistivity profiles show conductive areas dipping in both directions or subvertical) or simply younger faults associated to the inversion that has been documented in the North Sea in the Late Cretaceous, the mid-Paleocene, and again in the mid-Tertiary. The Middle to Late Miocene compression phase has been documented along the Norwegian margin from 62°N to 68°N. Reverse faults are locally observed on the More margin (Loseth and Henriksen, 2005). Maybe the offset of these faults, has been added to the TF in the fission track studies. In addition to this, when I see profile 2, there seems to be an offset in reflectivity around CMP 1200-1300 that would agree with a SE dipping inverse fault although it couls also ve a subvertical fault. I know that this interpretation does not help to give information about the major TF but faults are not always visible in the seismic profiles and imaging a km scale offset fault in a 1.5 TWT profile is not an easy task.

On the other side, I'm not very convinced that the anticline/syncline like reflection observed in both profiles represents the boundary with an eclogitic lower crust. I see more likely that it represents the folded amphibolite lenses that outcrop near profile 2.

SED
4, C65–C68, 2012

The fact that they appear shallower in profile 1, does not necessarily give the plunge of the anticline. In fact, the outcrop of amphibolites near profile 2, indicated a plunge to the NE so changing it to the NW is not irrelevant. Amphibolites appear in discontinuous lenses, (as we can see in Figure 2) and the authors maybe observing two different lenses in these profiles. If they still think that what they see is a eclogitized shear zone in the lower crust, they have to keep in mind that it could be more continuous, it indicates a plunge different to that indicated by the outcrop of amphibolites and it does not seem to outcrop in the area, at least, in the map they provide. Only garnetiferous gabros outcrop in the NW of Figure 2, but they are not eclogites and appear as a very continuous band. The map does not help to see if that band is structurally above or below the profile.

Finally I think TF should cut the anticline. Folding as observed in the amphibolites is old (Scandian? or older) and TF has been reactivated several times since then. Besides, a 50-100 km long Devonian fault with km scale offsets probably cuts every structure, at least, down to the fragile-ductile transition. But, the faults the authors are imaging probably have very limited offsets and they don't need to cut the imaged anticline. Although as I said before, the northwestern end of profile 2 shows a significant offset in reflectivity. Minor comments: 1) I'd like that figure 1 had a geological map of southern Norway, where we could see the boundaries of the WGR and if possible, some outcrops of the eclogitized lower crust. Also, it could be added to Figure 2. 2) In page 248, line 13, you say the used bedrock velocity is constant and 5200 m/s and in page 249 you say velocity is 5.5 km (add per second and use SI units, i.e. m/s). Which was the velocity used? 3) Electric profile 4 shows a subvertical or highly NE dipping fault that divides a conductive zone to the N from a resistive zone to the S. Shouldn't that be the best candidate for TF? 4) The seismic profiles, shot gathers and the resistivity profiles should be oriented all the same: Preferably N to the left and S to the right. It is difficult to follow the dip of events when you change the orientation. 5) Shots/stacks should be shown without the modeled travel times first so we can judge how good is the fitting and the amplitude and frequency of reflectors (Figures 6, 7 and 9). 6) Also, ortography must be revised. There are some errors (e.g. pag 251, line 23, has instead of have? line 25, a instead of an? shows instead of show? line 26, correlates instead of correlate?)

Interactive comment on Solid Earth Discuss., 4, 241, 2012.