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Dehydration-induced earthquakes and apparent slab pull in a subducted oceanic slab beneath Vrancea, Romania

Thomas P. Ferrand[1], Elena Manea[2,3], Andreea Craiu[2], Johannes C. Vrijmoed[1], and Alexandru Marmureanu[2]

[1]Institut für Geologische Wissenschaften, Freie Universität Berlin, Malteserstraße 74-100, Berlin 12249, Germany
[2]National Institute for Earth Physics, Calugareni, 12, Măgurele, Ilfov, Romania
[3]GNS Science, PO Box 30-368, Lower Hutt, New Zealand

Vrancea, Eastern Romania, presents a significant intermediate-depth seismicity, between 60 and 170 km depth, i.e. pressures from 2 to 6.5 GPa. A debate has been lasting for decades regarding the nature of the seismic volume, which could correspond to the remnant of a subducted slab of Tethyan lithosphere or a delamination of the Carpathians lithosphere. We present P-T diagrams showing to what extent these hypocentral conditions match the thermodynamic stability limits for minerals typical of the uppermost mantle, oceanic crust and lower continental crust.

Most triggering conditions match relatively well antigorite dehydration between 2 and 4.5 GPa; at higher pressures, the dehydration of the 10-Å phase provides the best fit. This demonstrates that the Vrancea intermediate-depth seismicity is evidence of the current dehydration of an oceanic slab beneath Romania. Our results are consistent with a recent rollback of a W-dipping oceanic slab, whose current location is explained by limited delamination of the continental Moesian lithosphere between the Tethyan suture zone and Vrancea.

In addition, we investigate the potential link between the triggering mechanisms and the retrieved focal mechanisms of 940 earthquakes, which allows interpreting the stress field distribution with depth. We observe a switch from collision to vertical extension between 100 and 130 km depth, where the Clapeyron slope of serpentine dehydration is negative. The negative volume change within dehydrating subhorizontal serpentinized faults (verticalized slab) likely explains the vertical extension recorded by the intermediate-depth seismicity. This apparent slab pull is accompanied with a rotation of the main compressive stress, which could favour slab detachments in actively subducting slabs.