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The OGS local virtual seismic network in South-Central Europe as an array: exploiting depth phases to locate upper mantle discontinuities

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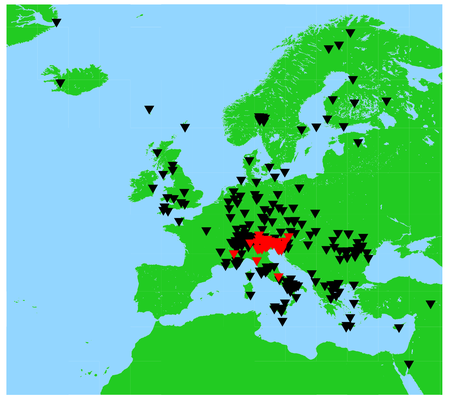
ABSTRACT

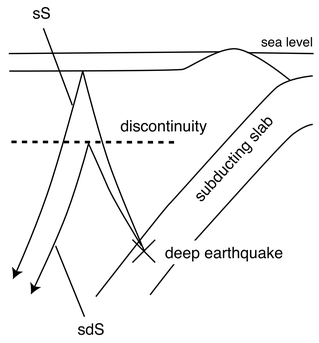
The Centro di Ricerche Sismologiche (CRS, Seismological Research Center) of the Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS, Italian National Institute for Oceanography and Experimental Geophysics) in Udine (Italy) after the strong earthquake of magnitude Mw=6.4 occurred in 1976 in the Italian Friuli-Venezia Giulia region, started to operate the North-eastern Italy (NI) Seismic Network: it currently consists of 13 very sensitive broad band and 21 simpler short period seismic stations, all telemetered to and acquired in real time at the OGS-CRS data center in Udine. Real time data exchange agreements in place with neighbouring Italian, Slovenian, Austrian and Swiss seismological institutes lead to a total number of 94 seismic stations acquired in real time, which makes the OGS the reference institute for seismic monitoring of North-eastern Italy. In this study we use P, pP, S and sS phases from global events recorded by the OGS local virtual seismic network in South-Central Europe to study upper mantle discontinuities above earthquakes in the subducted Pacific Plate. We use the time lag between the surface-reflected depth phase and a precursor to determine the discontinuity depth. Accurate estimation of reflector depth depends on a velocity model of the source-side mantle structure. In contrast to typical one-dimensional velocity models, our source-side structure is oceanic, with a shallow Moho and thin crust overlain with water. The time lag between the direct P and pP or S and sS arrivals without accounting for source structure can be as large as 5 s when compared to a purely continental model like iasp91 or ak135. We identify upper mantle discontinuities using slant stacking and depth-migrated standardized waveforms. The processing shows S-to-P arrivals from the 660 km discontinuity, the 410 km discontinuity, and shallower upper mantle ones of uncertain origin.

Waveform data from OGS and ORFEUS

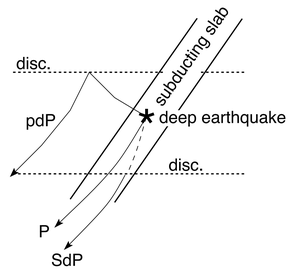
European and OGS stations



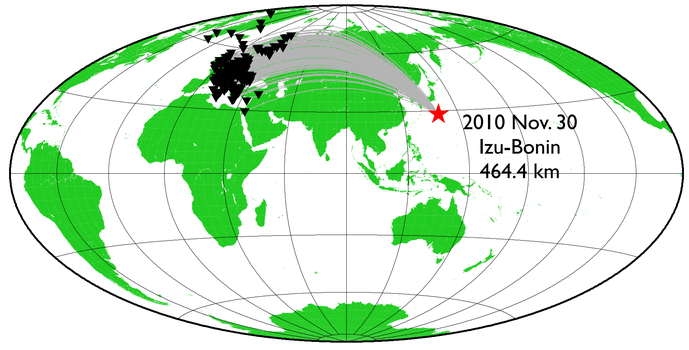
Near-surface targets



Deep targets



Paths



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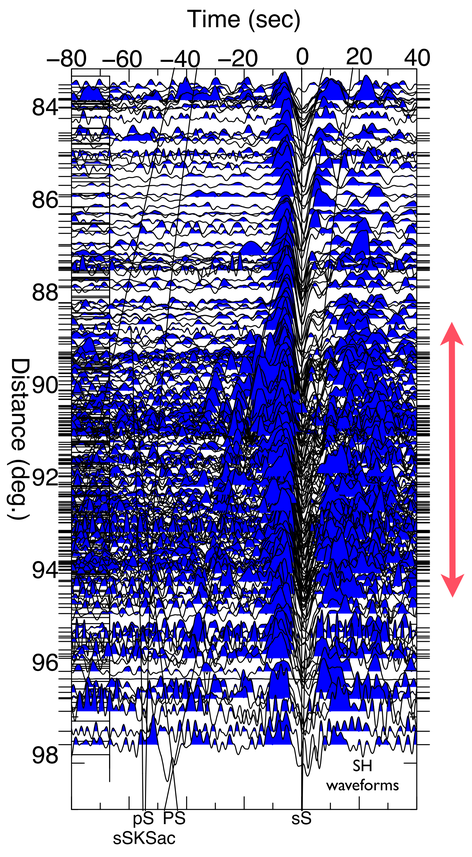
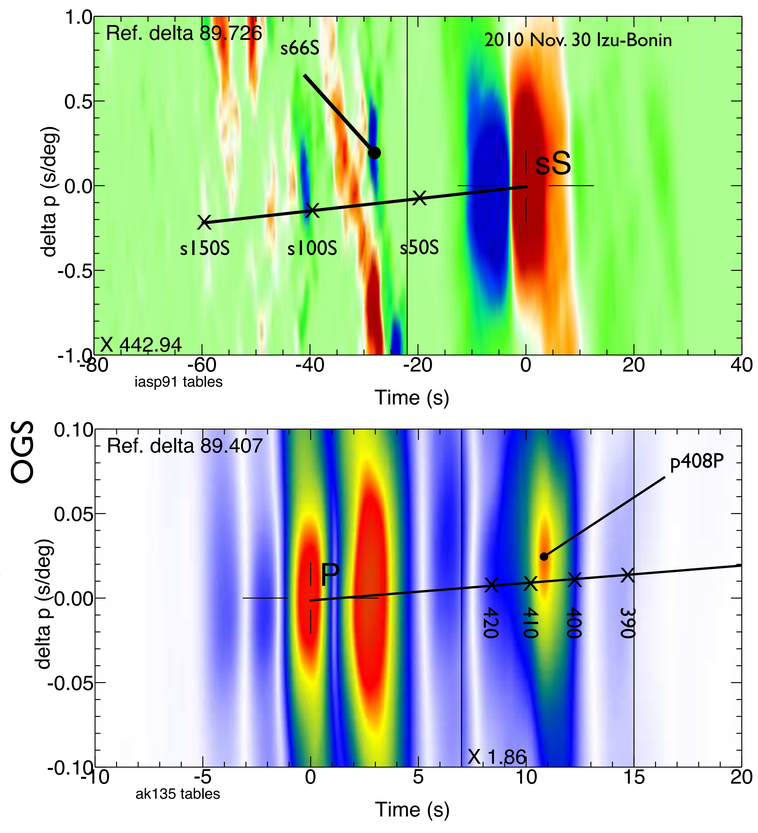


Vespagrams



Results

(top) Opposite polarity arrival to seafloor sS marks velocity decrease at ~66 km depth -- oceanic LAB[3]. Waveforms at left.

(bottom) Envelope of stacked P arrivals shows pdP arrival from 410 km discontinuity at 408 km.

Adaptive stacking[1] used to remove static delays, phase-weighted summation[2] to suppress noise.

Conclusions

Slowness resolution of regional network array, corrected for local structure delays, is a primary deep-earth research tool.

References:
[1]Rawlinson & Kennett (2004) GJI, 157, 332-340.
[2]Schimmel & Paulssen (1997) GJI, 130, 497–505.
[3]Tonegawa & Helffrich (2011) submitted.