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Microtremors, Ocean Waves, and Other Items

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SUMMARY

Ocean waves are known to be a dominant component of microtremors worldwide in the frequency band from 1 to 10 Hz (Peterson, 1993). Recently, Lambert et al. (2009) claimed that spectral anomalies in microtremors can detect underlying hydrocarbon reservoirs. However, Hanssen and Bussat (2008) and Ali et al. (2010) got experimental results leading to opposite conclusions, because of the lack of signal repeatability and the correlation between spectral anomalies and near-surface topography. This paper expands the related work of Nieto et al. (2011) with new data from the OGS Seismological Network (OASIS Working Group, 2011) and the Marine Environmental Monitoring Network, showing that geological structures and active faults may be locally dominant factors too.

Introduction

Ocean waves are known to be a dominant component of microtremors worldwide in the frequency band from 1 to 10 Hz (Peterson, 1993). Recently, Lambert *et al*. (2009) claimed that spectral anomalies in microtremors can detect underlying hydrocarbon reservoirs. However, Hanssen and Bussat (2008) and Ali *et al*. (2010) got experimental results leading to opposite conclusions, because of the lack of signal repeatability and the correlation between spectral anomalies and near-surface topography. This paper expands the related work of Nieto *et al*. (2011) with new data from the OGS Seismological Network (OASIS Working Group, 2011) and the Marine Environmental Monitoring Network, showing that geological structures and active faults may be locally dominant factors too.

An integrated case history

Fig. 1a shows a map of North-western Italy where the data was acquired: yellow pins indicate seismological stations, the red square is the OGS test site in Torrate, and the three green dots are oceanographic buoys in the Gulf of Trieste. The blue segments show the average polarization of microtremor at the seismological stations for time intervals of 1 hour, with a length proportional to the percentage along that direction. We notice that in the central part the dominant direction is parallel to the mountain trenches, while it is much more dispersed in the North-eastern stations in the higher mountain area. The Western-most station is strongly polarized orthogonal to the shore of the Garda Lake. Similarly, the station in Trieste shows an average direction along the median line of the gulf (yellow continuous line), while the strongest outliers are pointing (yellow dotted line) towards the seismogenic area close to Gemona (orange ellipse). This secondary trend may be related to the active faults in that region. Fig.1b depicts dip and azimuth of the average polarization over time intervals of 1 hour at the Trieste seismological station. It looks like the plot for passive seismic data acquired while injecting brine into a producing reservoir (Vesnaver *et al*., 2010), where a background trend is overlaid by similar sparse spikes. As we know that these spikes in the Trieste records are due to earthquakes, we may guess that similar phenomena occur at reservoir scale for micro-earthquakes.

Conclusions

Ocean waves are a ubiquitous background for microtremors, but active faults and geological wave guides (as valleys and mountain trenches) influence the local signal a lot. Without removing these factors, spectral analysis of microtremors cannot provide reliable information about deep targets.

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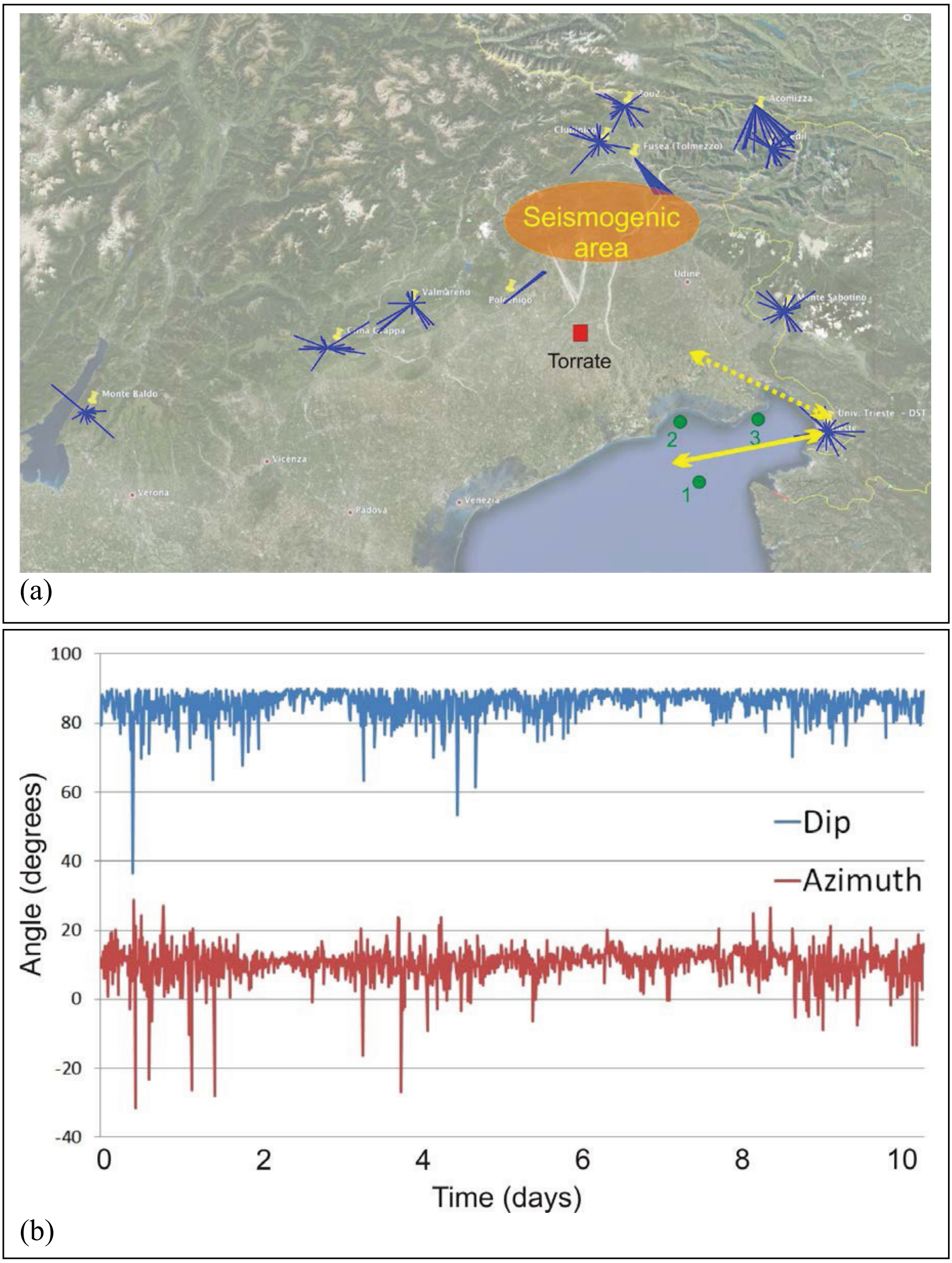

Figure 1 *Location of the available seismological stations and oceanographic buoys in North-eastern Italy (a) and plot of dip and azimuth angles, average for 1 hour time intervals, for a duration of 10 days (b).*