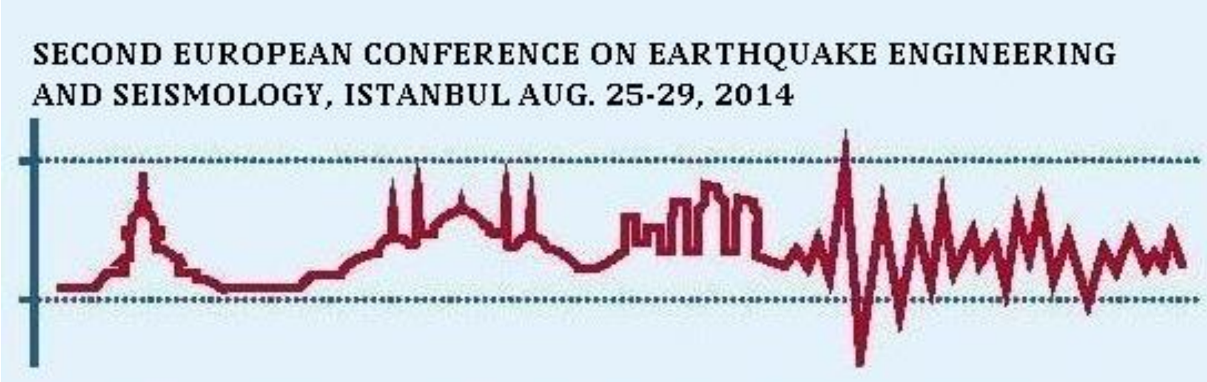

THE HELLENIC SEISMOLOGICAL NETWORK OF CRETE (HSNC):RECENT RESULTS OF ITS OPERATION IN THE FRONT OF THE HELLENIC ARC.

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The number and quality of seismological networks in Europe has increased in the past decades. Nevertheless, the need for localized networks monitoring areas of great seismic and scientific interest is constant. Hellenic Seismological Network of Crete (HSNC) covers this need for the vicinity of the South Aegean Sea and Crete Island. Convergence of the Eastern Mediterranean plate and the small Aegean plate at 4cm/y rate creates a complex tectonic environment. In this area, more than 60% of the total seismic energy in Europe is being released with magnitudes up to 8.3 (Papazachos, 1990). The subduction of the Mediterranean plate under the Aegean plate creates the Benioff zone of intermediate and deep earthquakes, as it has been revealed from tomographic results (Sparkman, 1988, Papazachos and Nolet, 1997).

HSNC started its operation in 2004 and within a decade it is built to the current state of 14 online stations (fig.1). All stations are equipped with Reftek 130-01 digitizer that continuously records data @100 Hz. Initially Guralp CMG-40T 1 sec sensors were installed, which have been substituted with Guralp CMG ESPC 60 and 120 sec. Communication with the central station is established by using private wired ADSL MPLS VPN lines, satellite lines, and RF. HSNC has its own private satellite hub allowing single-hop communication between central station and VSATs (Hloupis et al., 2013). Data collection is achieved using commercial RTP software (www.reftek.com). All stations are registered to International Seismological Centre (ISC) and the network is listed by International Federation of Digital Seismograph Networks (FDSN) with the assigned permanent network code HC.

HSNC operates continuously collecting data from its 14 stations and 10 more stations from neighboring networks. HSNC has signed bilateral agreements with NOA, AUTH and KOERI ensuring an exchange of data. Data from neighboring networks are fed to RTP using sl2rtpd protocol transforming mini-SEED data to Reftek format. For automatic processing of seismic signal, we employ two Earthquake Monitoring Systems: SNDP (Synapse Seismic Center, Russia) and SeisComp (Deutsches GeoForschungsZentrum, Germany) that run independently and in parallel. Both EMS create automated bulletins which are being distributed to registered users and authorities. Manual analysis of seismic events is being conducted by trained personnel and event messages are sent to registered users and authorities. A dedicated webpage is being updated after every event, presenting space distribution of events (www.gaia.chania.teicrete.gr). The complete catalogue of seismic events is available under request.

Another automated system is running in parallel with EMS, monitoring the uninterrupted flow of data to the central station. For this purpose, we employ Nagios software (www.Nagios.org). The purpose of Nagios is dual: monitoring communications between remote stations and central station, and alerting administrators about problems with connectivity in various levels. Nagios automatically checks connectivity with stations using ping command. If a station fails to respond to ping, an alert is

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issued via SMS and e-mail to the administrator of network. Nagios also monitors all servers running within the central station, monitoring hard drive space, CPU load, RAM/swap memory and processes running, alerting the administrator if values reach a warning/critical state.

The spatial variability of Magnitude of Completeness (M_c) is calculated from HSNC's manual analysis catalogue of events with the use of Z-map software (www.seismo.ethz.ch) for the period of 2011 until today. Calculation of M_c is done using the "best combination" option of Z-map which compares the Maximum Curvature Technique (Wyss et al. 1999) and the Goodness-of-Fit Test (Wiemer and Wyss, 2000). The M_c estimation methods are based on the validity of Gutenberg-Richter Law (Mignan and Woessner, 2012). Figure 2 illustrates the distribution of M_c for HSNC. M_c value at the close vicinity of Crete Island is down to 1.8 at the western and southern part of the island, and down to 3.3 at the eastern part of Crete.

In 2013, two major events occurred in the vicinity of Crete Island. Both events were at shallow depths (<40 Km). On October 12, 2013, a major event occurred with magnitude Mw=6.4 at the western part of the island. Using the method described above for the aftershock sequence, we calculated M_c value near to 1.6, proving the good coverage of HSNC in the area. On June 15, 2013, a strong mainshock occurred with magnitude Mw=6.2 at the South of the island. The next day a large aftershock with magnitude Mw=5.8 at the same depth of 10 km occurred. Using this aftershock sequence to calculate M_c, we derived to similar results for the South part of Crete Island, showing again good coverage of the area.

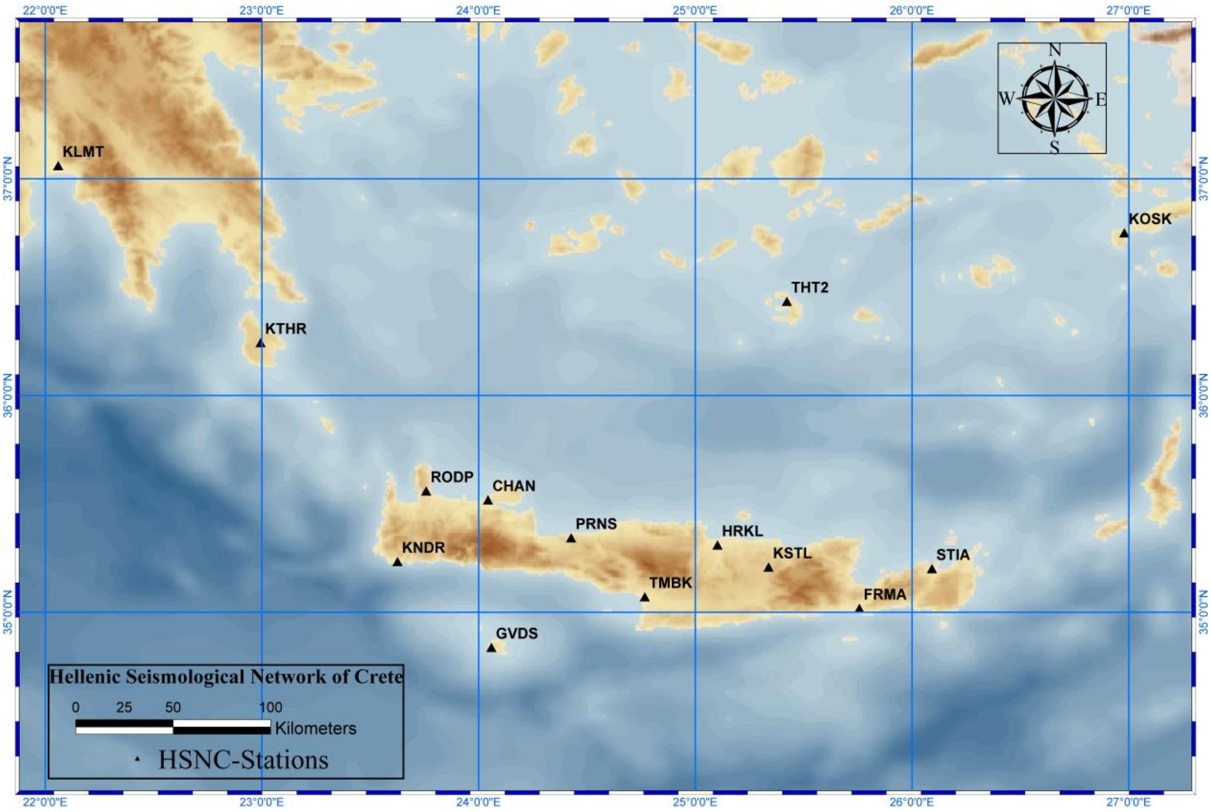

Figure 1. Map of Crete showing the distribution of seismologic stations in Crete and surrounding regions.

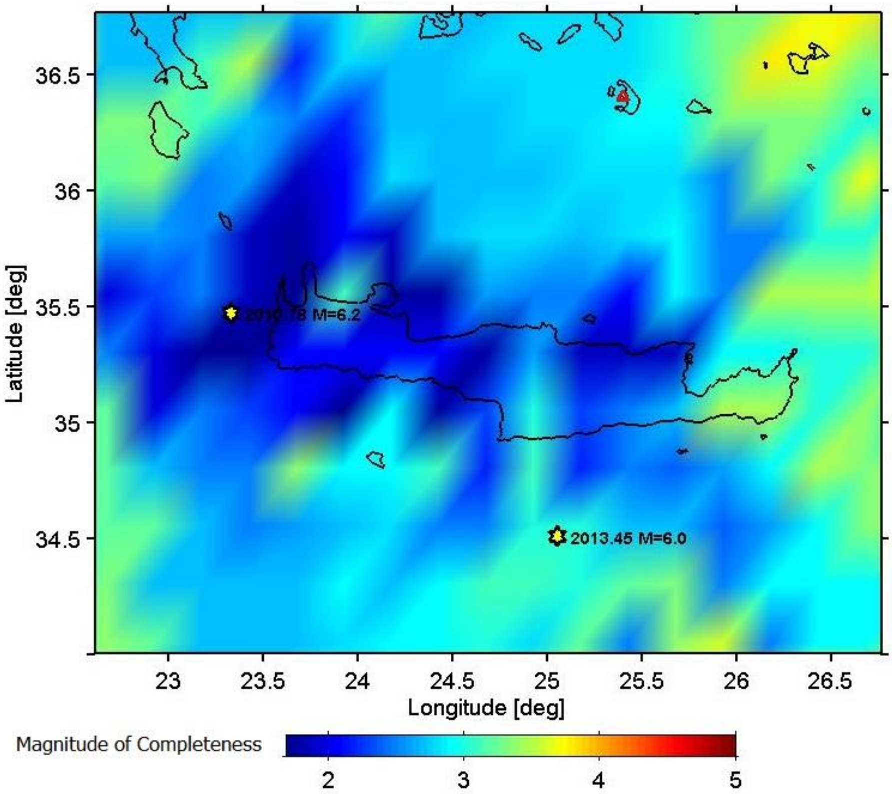

Figure 2. Magnitude of Completeness for HSNC station distribution.

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REFERENCES

Hloupis, G., Papadopoulos, I., Makris, J. P., and Vallianatos, F. (2013), The South Aegean seismological network – HSNC, *Adv. Geosci.*, 34, 15-21, doi:10.5194/adgeo-34-15-2013

Mignan, A. and J. Woessner (2012), Estimating the magnitude of completeness for earthquake catalogs, *Community Online Resource for Statistical Seismicity Analysis*, doi:10.5078/corssa-00180805.

Papazachos, B.C. (1990). Seismicity of the Aegean and surrounding area, *Tectonophysics*, 178, 287-308

Papazachos, C.B. and G. P. Nolet (1997). P and S deep velocity structure of the Hellenic area obtained by robust nonlinear inversion of travel times. *J. Geophys. Res.*, 102, 8349-8367

Spakman, W., 1988. Upper mantle delay time tomography with an application to the collision zone of the Eurasian, African and Arabian plates. *Ph.D. Thesis, Univ. of Utrecht*, 53, 200pp.

Wiemer, S., and M. Wyss (2000), Minimum magnitude of complete reporting in earthquake catalogs: Examples from Alaska, the Western US, and Japan, *Bull. Seismol. Soc. Am.*, *90*, 859-869

Wiemer, S., D. Giardin, D. Fah, N. Deichmann, and S. Sellami (2009), Probabilistic seismic hazard assessment for Switzerland: best estimates and uncertainties, *J. of Seismology*, doi:10.1007/s10950-008-9138-7