Report for the Cost Flows STSM in the Bullard Laboratories of the Department of Earth Sciences of Cambridge University

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1. Summary

A Short Term Scientific Mission (STSM) of four weeks within the COST-FLOWS programme, was carried out in Bullard Laboratories of the Department of Earth Sciences at Cambridge. The purpose of this mission was to interact with the group of Professor Robert White who is working on magma-induced seismicity in Iceland and to work with Louis Géli, researcher of Ifremer, who is currently in sabbatical leave at the University of Cambridge. During this mission several goals were achieved and the results obtained were in light of the objectives of the COST-FLOWS Action. Special focus has been given to the verification of the results of the automatic picking provided by Early-Est, on the seismic data recorded by the temporary seismic network deployed by Ifremer in September 2014, in the Sea of Marmara (SoM). The detected events by Early-Est were classified into three different families according to signal characteristics. One family, Family 3, corresponds to aseismic events, hence events that could not be part of the final seismic catalogue. The discussion with the group of Professor White on their studies regarding the induced seismicity associated with geothermal systems in Iceland, was really enriching and helpful for my current work, which is based on the study of induced seismicity associated with gas reservoirs in the SoM.

2. Introduction

Since the last devastating earthquakes of 1999 in Turkey, the submerged part of the North Anatolian Fault (NAF) in the Sea of Marmara called Main Marmara Fault (MMF), is considered as a seismic gap. In order to assess the seismic hazard of the area, it is essentially important to determine the mechanical behaviour of the different submarine fault segments, by particularly studying the micro-seismicity. The MMF has been shown to exhibit clusters of seismicity, where their origin has been interpreted until now only in terms of tectonically driven. However, recent studies have shown that the MMF cuts a hydrocarbon reservoir, as part of the Thrace Basin (e.g. Géli et al, 2008, Bourry et al, 2009, Dupré et al, 2015) and therefore gas induced seismicity should be also considered for the interpretation of these seismicity clusters. The purpose of the current STSM in Cambridge University was : (i) The verification on the results obtained by Early-Est , by processing the seismic data recorded by the temporary seismic network of ten Ocean Bottom Seismometers (OBS) deployed by Ifremer in September 2014 and (ii) The interaction with the group of Professor Robert White, who is working on the magma-induced seismicity in Iceland.

3. Objectives of STSM in Bullard Laboratories

3.1 Verification of Early-Est results

The processing of the seismic data was performed by Early-Est (e.g. Lomax A. and Michelini A., 2012), which is a software package for phase picking, phase association and event detection-location. The first objective of this STSM was the verification of all the events that were associated-located by Early-Est for (i) assuring that the results of automatic picking were correct and (ii) for creating a final seismic catalogue, with correct picking phases and hence reliable earthquake locations.

Our results indicate that Early-Est has detected three different families of events :

(i) *Family 1* : Corresponds to seismic events with clear P and S phases (see Figure 1)

(ii) *Family 2* : Corresponds to seismic events, where the P phase was not well identified (see Figure 2)

(iii) *Family 3* : Corresponds to aseismic events of weak amplitude with weird signal, produced simultaneously on all OBS stations where they are observed (see Figure 3)

Every single event was individually examined and classified into Family 1 to 3 according to its signal characteristics. Events that did not have a clear signal on some stations, were deleted to ensure that the final catalogue contains only well resolved events. Manual corrections were applied to automatic picking to improve either the picking phases on P or on S wave.

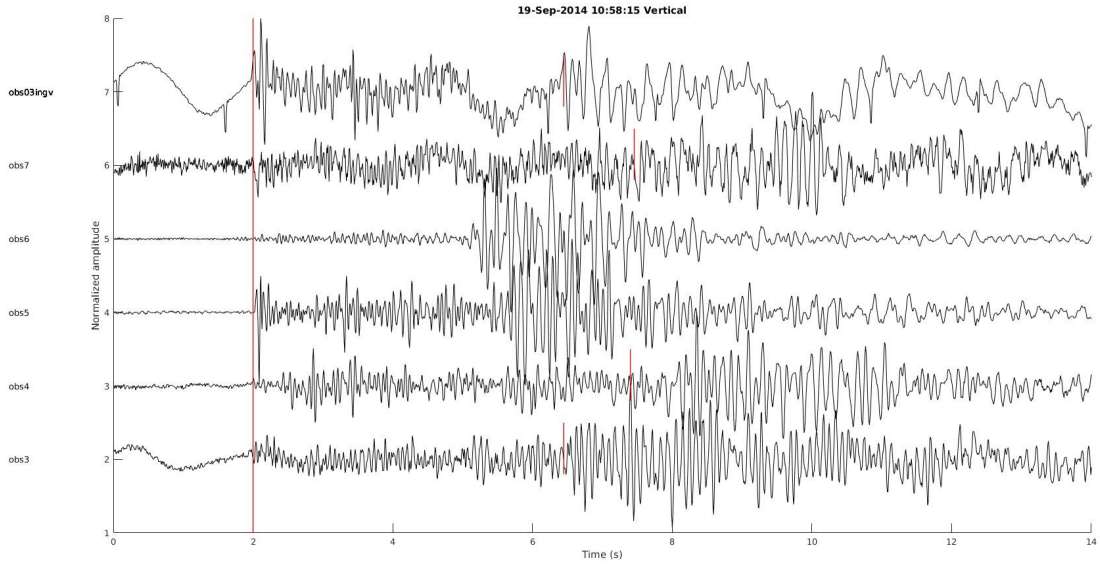

Figure 1 : Seismic event of Family 1, shown on the vertical component, recorded by different OBS stations, aligned on the P-phase identified by Early-Est (red vertical line)

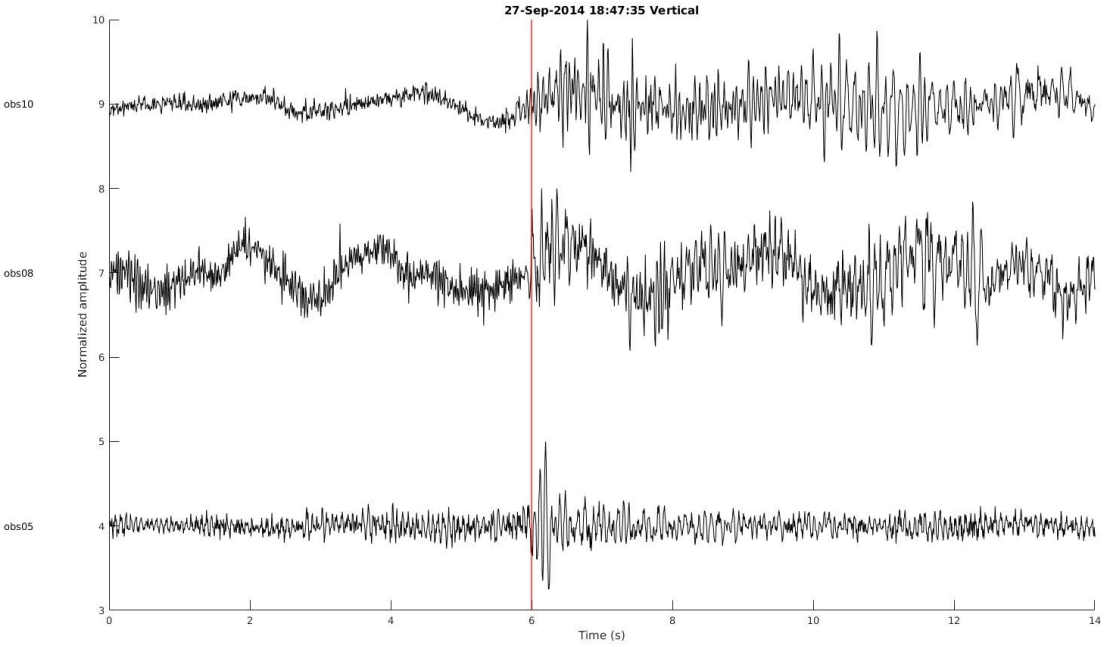

Figure 2 : Seismic event of Family 2, shown on the vertical component, recorded by different OBS stations, aligned on the P-phase identified by Early-Est (red vertical line)

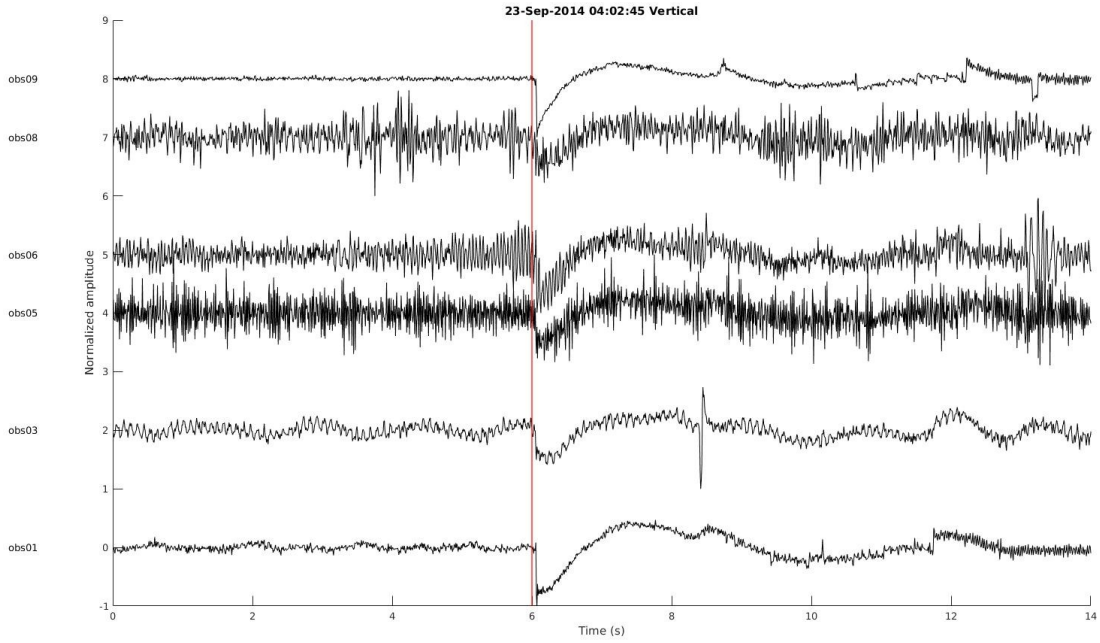

Figure 3 : Aseismic event of Family 3, shown on the vertical component, recorded by different OBS stations, aligned on the P-phase identified by Early-Est (red vertical line)

3.2. Comparison of seismic signals collected in different geological enviroments

The second objective of this STSM was to work on gas-induced seismicity along the NAF in the Sea of Marmara (SoM) and to interact with the group of Professor Robert White, who is working on magma-induced seismicity in Iceland. One of the main difficulties of my work regarding the seismicity in the western SoM is the discrimination-classification of the different types of seismicity (e.g. natural tectonic earthquakes vs gas-induced earthquakes). Therefore, the comparison of different seismic signals collected in different geological environments as well as the methodologies and algorithms used by the group of Professor Robert White were really useful for my work. The scope in the future is to adopt their algorithms on my study area for improving my current results.

4. Results

The submerged section of the North Anatolian Fault within the Sea of Marmara is one of the current working areas of FLOWS members. The results obtained during the STSM, were in light of the objectives of the COST-FLOWS Action. These results will enhance our

current knowledge for better understanding the interplay between seismic activity and fluid dynamics at the NAF transform plate boundary and were relevant with the goals of COST-FLOWS and of the four Working Groups within the FLOWS Action .

5. References

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