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Investigation of the characteristics and the triggering mechanisms of the seismicity in the Açu reservoir (NE Brazil).

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The aim of this study is to investigate the characteristics of micro-earthquakes which occurred in the area of the Açu reservoir (NE Brazil) and to ascertain their triggering mechanism. This work is part of a wider research project on the relationship between the permeability and seismicity within faults currently being undertaken by the Universities of Strathclyde, Glasgow, Boston and Rio Grande do Norte.

The Açu reservoir (NE Brazil) was formed in 1983 after the construction of the Açu dam. It is a shallow reservoir with a depth of 31m but covers a wide area over a semi-arid region and can store up to 2.4 billion cubic meters of water. A causative relationship between the increase in seismic activity recorded shortly after the impoundment of the reservoir and the pore diffusivity has been suggested by Ferreira et al. (1995) and do Nascimento et al. (2004).

The data used in this study consisted of the 3-component seismograms of 242 earthquakes and were recorded by 15 digital stations located at the rim of the Açu reservoir at sample rates of 200 samples/s and 500 samples/s. Not all stations were used simultaneously. Five different station configurations were used during the 3-yr long time period (1994 - 1997) covered by the data with at least 7 - 8 stations recording each time.

Duration magnitude was used to characterise the magnitude of the earthquakes in Açu. This is an appropriate magnitude measure as (1) it is similar to the Richter scale and (2) it works well for small earthquakes, such as the earthquakes in the Açu reservoir. The Duration Magnitude of the examined earthquakes was found to vary between 0.3 - 2.1.

A cluster analysis was also undertaken to relocate the earthquakes at Açu more accurately. In order to have uniform data, all seismograms recorded at all 15 stations were resampled into a rate of 1000 samples/s. Then the technique of the waveform cross-correlation was applied for each station separately; the traces were correlated and similar traces (corr. coef. > 0.8) were grouped into the same cluster. This process resulted in 47 clusters (for each station) consisting of at least two and up to nine events.

The arrival times of the P and S waves were repicked. The new picks have been moved by 0.3 to 5.5ms which corresponds to a difference in distance of 1.8 to 33m from the location of the station. A time correction (< 20ms) was also added to the new picks. Time corrections were applied in cases where the clocks of the stations were drifting with time.

The new relocations have a horizontal error of up to 50m, while the vertical error is up to 40m, which is rare, as almost all cases of earthquake location reviewed in published literature are reported to have a minimum error of at least 100m.

Examination of the new locations reveals that the hypocentres are aligned in a NE zone in streak patterns, and dip to the NW. Analysis of the best fitting plane results in a strike of N48E and a dip of almost 90 degrees.

This tendency of the hypocentres to occur on a vertical plane and expand over time is suggested by Vidale and Shearer (2006) as evidence that the pore fluid pressure fluctuations is the most likely mechanism to trigger the earthquakes. This assumption is also supported by the fact that the maximum seismicity is observed 135 days after a maximum peak in the water level. Furthermore, a large number of these events occur in close proximity to one another, suggesting strong earthquake interaction. This implies that the events are tending to trigger rupture on adjacent fault segments (self-organisation or self triggering).

Preliminary investigation of the existence of seismicity migration has revealed that events are temporally and spatially scattered and follow no specific pattern. The fact that the events are not migrating over depth during time suggests that the fault diffusivity structure is heterogeneous.

The examination of the source dimensions, the rupture velocity and the rate of healing is still in process. These results will be used along with geologic evidence in numerical modelling as a next step to shed more light on the understanding of the interaction between permeability and seismicity within faults.

References

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