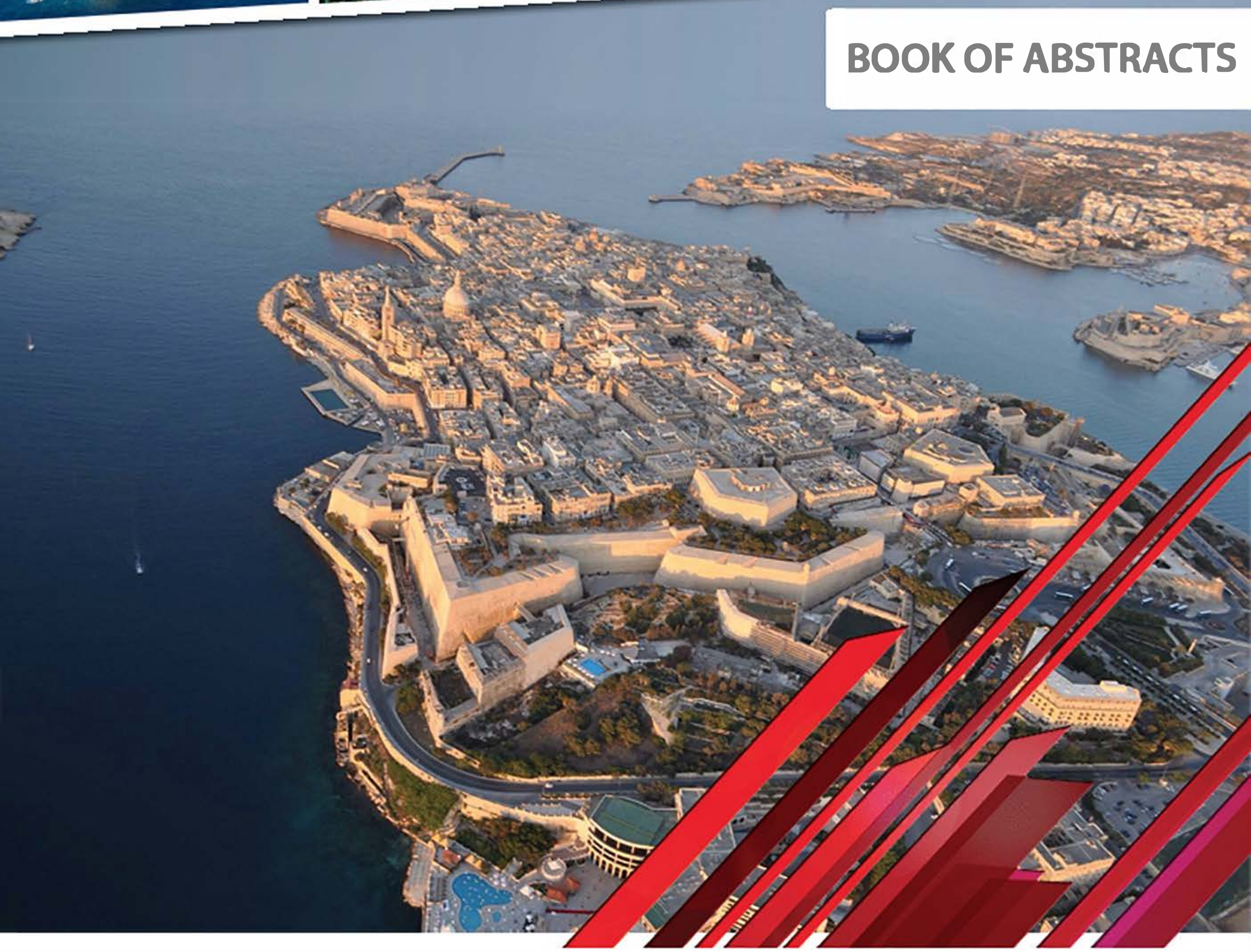

BOOK OF ABSTRACTS

36th General Assembly of the

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Sebastiano D'Amico, Pauline Galea, George Bozionelos, Emanuele Colica, Daniela Farrugia and Matthew R. Agius (Eds.).

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KEYNOTE LECTURES

ESC2018-S21-456

FLUID INITIATION OF ROCK SAMPLE FRACTURE: LABORATORY MODELING OF TRIGGERED SEISMICITY

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It is widely accepted at present that the infiltration pore pressure plays a controlling role in reservoir triggered seismicity. When water from a reservoir infiltrates into the rock mass at the depth of several kilometers, the increasing pore pressure reduces the effective stress, thereby lowering the shear strength of a potential seismogenic fault in the vicinity. This may initiate a crack, which would propagate and trigger an earthquake. The complex mechanisms of RTS are not yet well understood due to the very limited knowledge of the rheology of crustal material and groundwater movement under high pressures and high temperature conditions in the hypocenter region. Therefore, in the absence of instrumental data directly from the hypocentral zone, laboratory experiments on interactions of fluid infiltration, pore pressure and acoustic emissions of selected samples can provide vital insights on processes which take place in the crust. We have used dry cylindrical samples (length 60 mm, diameter 30 mm) of granite from boreholes in the Koyna-Warna area, western India for our laboratory experiments, which were carried out under two different confining pressures, 10 and 25 MPa, with pore pressures varying between 1 and 5 MPa. Uniaxial load applied to the dry sample under confining pressure of 10 MPa created a complex fracture zone in the sample. Then the loading rate was reduced by an order of magnitude and water was injected into the sample to pressure of 1 MPa, by which time the dry sample was water saturated. The pore pressure was now increased by consistent jumps from 1 MPa to 3 MPa. The same process was repeated under confining pressure of 25 MPa. The reaction of the samples to strain and pore pressure is recorded as acoustic emission (AE) patterns. The following observations were apparent after post processing the data: (i) background AE occurs almost simultaneously with flow of fluid into the dry sample. (ii) at smaller values of pore pressure (1 MPa) maximum AE is observed with a time delay relative to the pore pressure front, leading to a 'swarm activity' of acoustic response. (iii) At 2-3 MPa pore pressure and beyond, the AE is 'aftershock like', particularly noticeable during the first injection of the fluid in a relatively dry fractured zone. Stepwise increase of pore pressure causes a corresponding response in acoustic activity, linearly dependant on the magnitude of the pressure. Re-injection into an already saturated sample showed AE diminished by an order of magnitude. We find that the delay in the initiation of fracture during the propagation of fluid in a dry rock was several times greater than under the propagated diffusion of pore pressure in a water saturated rock. The effect of the difference in diffusion rates due to the difference in the coefficients of effective permeability is known in the theory of fluid filtration. It was indicated earlier that this difference can be as high as one order. Through several experiments, the effect of a noticeable delay in the maximum of the acoustic response relative to the onset of pore pressure (tens of seconds or more) was revealed. It should be noted that in real conditions, the induced seismicity in the Koyna-Varna region is also characterized by both a rapid and delayed response to the filling of reservoirs, and the delay mechanism remains not completely clear. The results of the conducted experiments qualitatively confirm the assumption about the nature of reactivation of seasonal seismicity in the south of Koyna-Warna area due to the different rate of initial watering and subsequent pore pressure fronts caused by the filling and operation of the Koyna and Warna reservoirs. Financial support under the Russian-Indian project RSF - DST India: RSF grant No. 16-47-02003, grant of the Department of Science and Technology, Government of India, INT/RUS/RSF/P-13 is gratefully acknowledged.

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