Geophysical Research Abstracts, Vol. 7, 06491, 2005
SRef-ID: 1607-7962/gra/EGU05-A-06491
© European Geosciences Union 2005

CREEP: Long-term time-dependent rock deformation in a deep-sea laboratory in the Ionian sea: a pilot study

P.G. Meredith (1), S.A. Boon (1), S. Vinciguerra (2) and NEMO Group (3)

(1) Department of Earth Sciences, University College London, UK, (2) Osservatorio Vesuviano, Istituto Nazionale di Geofisica e Vulcanologia, Naples, Italy, (3) Laboratori Nazionali del Sud, Istituto Nazionale di Fisica Nucleare, Catania, Italy (p.meredith@ucl.ac.uk)

Time-dependent brittle rock deformation is of first-order importance for understanding the long-term behaviour of the Earth's brittle crust. Interpretation of results from traditional laboratory brittle creep experiments have generally been in terms of three individual creep phases; primary (decelerating), secondary (constant strain rate or quasi-steady-state) and tertiary (accelerating or unstable). The deformation may be distributed during the first two, but localizes onto a fault plane during phase three. More recently, models have been proposed that explain the trimodal shape of creep curves in terms of the competition between a weakening mechanism and a strengthening mechanism, with the weakening mechanism eventually dominating and leading to localized failure. However, a major problem is that it is difficult to distinguish between these competing mechanisms and models given the lower limit of strain rates achievable in laboratory experiments over practicable time scales. This is important because such behaviour is often observed as a precursor to earthquakes and volcanic eruptions.

This project therefore aims to address that problem directly by extending significantly the range of achievable strain rates through much longer-term experiments conducted in a deep-sea laboratory in the Ionian Sea. The project takes advantage of a collaboration with the NEMO Group, a consortium that is developing a large volume (1 km^3) deep-sea detector for high-energy ($> 10^{19}$ eV) cosmic neutrinos. A suitable test site has been identified, some 20km north-east of Catania in Sicily, at a depth of 2100m.

A prototype deformation apparatus (CREEP) has been designed and built for the project. Within the CREEP apparatus, confining pressure is provided by the ambi-

ent water pressure (approx. 22 MPa), and the constant axial stress is provided by an actuator that amplifies this pressure. Measurement transducers and a data acquisition system are sealed internally, with power provided for up to 6 months by an internal battery pack. The great advantage of operating in the deep sea in this way is that the system is essentially passive, has few moving parts, and requires no maintenance. The apparatus is held in place by a disposable cast-iron anchor and supported above the seabed by a deep-sea buoyage system. On completion of each experiment, an acoustic release detaches from the anchor and allows the apparatus to float to the surface to be recovered by an oceanographic research vessel.

The prototype apparatus has been deployed from the oceanographic research vessels *Thetis* and *Universitatis* four times since March 2003, for periods from 3 days to 6 months. Results from a 4-month deployment (July to November 2003) show a rapid increase in sample strain during deployment as the apparatus sinks to 2100 m water depth, which takes about 15 minutes. The sample then creeps under constant applied differential stress for approximately 100 days before the onset of accelerating creep instability. The average creep strain rate during the main phase of deployment was approximately 5 x 10^{-11} s^{-1}, some two orders of magnitude lower than achieved in earlier laboratory experiments.