The Semi-controlled Earthquake-generation Experiments in South African deep gold mines (2005-2006)

Hiroshi Ogasawara[1]; Naoyuki Shimoda[1]; Makoto Naoi[1]; Akihito Yamamoto[2]; Hiroshi Ishii[3]; Shigeru Nakao[4]; Masao Nakatani[5]; Yoshihisa Iio[6]; Aleksander Mendecki[7]; Gerrie van Aswegen[7]; Sumitomo Norihiko International Research Group for Semi-controlled Earthquake Generation Experiment at South African Gold Mine[8]

[1] RitsumeiUniv.; [2] Ritsumeikan Univ.
; [3] TRIES; [4] Kagoshima Univ.; [5] ERI; [6] DPRI, Kyoto Univ.; [7] ISSI; [8] -

The talk digests the 2005-6 activity of the Research Group for the Semi-controlled Earthquake-generation Experiments in South African deep gold mines (SeeSA), including:
(1) An attempt to delineate the full detail of the transition from aseismic to seismic (from M=3 down to AE) events.
(2) The status of ICDP/NSF cooperating project at a 3.6km depth at a South African gold mine.
(3) A new research trend in flooded deep gold mines in South Africa

We thoroughly probed the 25Hz 24bit continuous strain recordings at an experimental site at the Bambanani mine (Ishii et al. 2000, JSS), where the seismic events with magnitudes of 2.4 and 2.5 took place within 100 m from the Ishii strainmeter (e.g. Takeuchi et al. 2003, AGU; Ogasawara et al. 2005, RaSim6). We found the Ishii strainmeter picks up seismic events smaller than M= -1 (a poster by Yamamoto et al., this meeting) much more than those catalogued by the mine's seismic network. Small, slow strain-steps were also frequently recorded with variable rise times with a moment possibly corresponding to M=-1 or smaller seismic events (an oral presentation by Naoi et al., this meeting). Only a little number of very slow events was preceded by the accelerating strain (Naoi et al. 2005 JSS). We should investigate in further detail if these are the transitions from slower preparation of smaller earthquakes to faster, larger earthquake. So, we start the strain monitoring with much higher sampling rate at the existing and new sites, attempting strain-seismological analysis. One of these is also carried out collaterally with Nakatani et al. (this meeting) who attempt to monitor the wide dynamic/frequency range of fracturing process from AE (up to 200 kHz) to seismic events at a potential seismic fault.

An ICDP project, Drilling Active Fault in South African mines, is being carried out at 120 L (about 3.6 km deep, the deepest active mining area in the world) at the Tau Tona mine. The purpose is not only to probe the fault zone and to monitor fault behavior with instruments, but also to investigate the potential effects of catastrophic fracturing during earthquakes on the subsurface microbiological communities and fault fluid and gas chemistry. This site is located on the Pretorius Fault a few km to the northeast and several hundred meters beneath our experimental site at 104/44 Mponeng mine. Three holes, 60, 60 and 40 m long, respectively, have been drilled through the fault zones. As of 7 February, the 4th hole is busy in drilling and we install an Ishii strainmeter in the fifth hole. Together with the instruments by the NELSAM project a dense array is deployed. We will report on the update of the project.

At many South African gold mines the maximum economical depths of about 3.6 km or greater have been reached. Associated with the mine closures, the mines are flooded, causing significant induced seismicities. In some cases, adjacent mines are still working, from which we can access to the flooded mine from underground. Then, such mines are very rare experimental site to investigate:
- The effects of flooding and the corresponding rising water levels on the stability of faults and other geological features.
- The effects of seismicity on inter-mine water plugs and mine barriers pillars
- Seismic damage risks to neighboring mines in areas in which mines are mature

These investigations are very interesting because the behavior of highly stressed rock mass during flooding is presumably analogous to that during natural earthquake swarms or stable/unstable slip at natural great earthquake hypocenters in water-saturated condition. Some South African organizations have started monitoring flooding induced earthquakes. We will report on the status of their monitoring and possibility to install Japanese monitoring array.