THE Mw 5.9 FEBRUARY 3RD 2008 BUKAVU EARTHQUAKE

N. d'Oreye[1], P. Gonzalez[2], A. Shuler[3], L. Bagalwa[4], G. Ekstöm[3], D. Kavotha[4], F. Kervyn[5], F. Lukaya[4], E. Osodundu[4], A. Oth[6]

[1]Dept. Geophys./Astrophys., National Museum of Natural History, Luxembourg, ndo@ecgs.lu
[2]Instituto de Astronomia y Geodesia, Univ. Madrid, Spain
[3]Lamont-Doherty Earth Observatory, Columbia University, NY, USA
[4]Goma Volcanological Observatory, CRSN, Democratic Republic of Congo
[5]Dept. of Carto. and Remote Sensing, Royal Museum for Central Africa, Belgium
[6]European Center for Geodynamics and Seismology, Luxembourg

1. INTRODUCTION

On February 3rd 2008, a Mw 5.9 Earthquake struck the cities of Bukavu and Cyangugu along the border between South Kivu in Democratic Republic of Congo and the Ruzizi District in the West Province of Rwanda. It caused widespread damages and killed at least 39 people according to the local authorities of DR Congo and Rwanda. The main earthquake was followed by a large number of aftershocks among which 12 were of magnitude 3.7 and above, including 3 above magnitude 5. That seismic episode took place on the Western branch of the East African Rift (EAR), on the Southern shore of Lake Kivu, about 100km South of Goma and the Nyiragongo volcano.

Following the USGS NEIC catalog (1974-to-present) the February 3rd 2008 earthquake is the largest event ever recorded in the area after the magnitude mb 6.2 earthquake of October 24th 2002 that occurred 35km South West of Goma.
It is of a particular importance because of its shallow depth and because it is associated to an intense seismic activity. Three temporary seismic stations deployed in the area recorded more than 700 aftershocks between February 8th and 27th. Yet another magnitude 5.3 event struck the area on October 5th 2008, few kilometers North of the Nyamulagira volcano.
One should go back in 1977 and 2002 (the years of the two only historical eruptions of the Nyiragongo volcano) to find such an intense activity in that part of the EAR, when respectively 2 and 7 earthquakes of magnitude above 5 where recorded. Only two other magnitudes >5 events are known respectively in 1981 and in 1995 (the year of the highest level reached by the lava lake in the crater of the Nyiragongo since its drainage in the course of the 1977 eruption). Although this can obviously not be considered as precursory to imminent eruption of the Nyiragongo, it definitely attests the current intense activity of that part of the Rift, as it is also noted e.g. with the intense activity of the Nyiragongo lava lake.

Unfortunately the Goma Volcanological Observatory (GVO) seismic network was not operated at the time of both February and October 2008 main events.
The poster presents the source parameters of the February 3rd event deduced from the InSAR data acquired in the frame of the SAMAAV and GORISK projects [1, 2] and from teleseismic waveforms recorded on the Global Seismographic Network.

2. SEISMIC DATA

Standard methods were applied to study long-period body and surface waves as well as broadband P and SH waveforms recorded on the Global Seismographic Network. Centroid-moment-tensor (CMT) solutions were calculated following the methods of [3, 4]. The moment tensor resulting from the CMT analysis shows a nearly pure double couple with scalar moment of 9.85×10^{18} N m. The motion on one of the nodal planes is described by the following angles: strike 4º, dip 53º, and rake -87º. Focal depth was constrained using a joint analysis of broadband teleseismic P and SH waveforms and the CMT data set using the methods of [5]. Calculations were made using a regional velocity model based on studies by [6,7], which is

used to locate earthquakes in this region [8]. The best fitting broadband source model has a focal mechanism that is very similar to the CMT solution and a centroid depth of 6.8 kilometers.

3. INSAR DATA

Fortunately Bukavu is just South of the area where we started a systematic SAR monitoring in 2005 [9]. The rich database allowed us to compute at least one interferogram with baselines conditions favorable enough to overcome the vegetation-induced decorrelation. The interferogram (computed using Doris software [10]) shows a single deformation pattern with a peak-to-trough line-of-sight deformation of about 10 cm (3 fringes). Fault plane geometry was modelled using a rectangular dislocation with uniform slip embedded in a homogeneous, isotropic and elastic half-space [11]. The deformation map was inverted using an unconstrained direct search nonlinear optimization algorithm, based on the simplex free-derivative method [12]. The source parameters derived from the best-fit inversion confirm the quasi NS strike angle derived from seismicity (strike 355º, dip 52º, and rake fixed to -90º). It also confirms the unusual shallow depth of the source (5.1 km $\pm$ 0.5 km) more commonly encountered in the volcanic field on the North of the lake.
The moment magnitude estimated from InSAR (Mw 5.89) is very close to the seismic estimate (Mw 5.9) suggesting that the observed deformation pattern is related to a brittle rupture with almost no aseismic slip.
The source dimensions and hypocenter location estimated from the present InSAR study confirmed what was suspected from field observations conducted by geologists shortly after the earthquake (absence of major fault traces at the surface and report by local population of water movements along some specific shore lines and islands): the event occurred underwater, South-West of Nkombo Island.

4. CONCLUSIONS

InSAR-derived estimates for the source parameters of the Mw 5.9 Bukavu earthquake are consistent with those estimated independently with the teleseismic data. In addition the remote sensed data brought valuable information about the location of the earthquake. Location and depth were in particular impossible to assess with high accuracy for there was no local seismic network available. This information might however be of a great importance for the hazard assessment in the context of a rift tectonic, a region prone to landslides and the presence of a large amount of carbon dioxide and methane gases dissolved in the Lake Kivu.

5. REFERENCES

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