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Reappraisal of single station locations reported by the SANSN

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ABSTRACT

Investigation of 1 380 earthquake epicenters we done located through the single-station location technique during routine analysis by the South African National Seismograph Network (October 2010 to December 2012). Epicenter location through single-station analysis was prompted by macroseismic reports originating in the towns of Ceres and Tulbagh which coincided with a disruption of seismological services at the Council for Geoscience due to an upgrade of the South African National Seismograph Network. Claims of increased seismicity could not be confirmed from waveform recordings during this study. Moreover, the practice of evaluating earthquake epicenters through single-station location was expanded during the period under review to other selective areas of the Republic which yielded unsatisfactory results. In conclusion only 25% of the originally located events could be confirmed.

Introduction

Critical epicentral solution evaluations of 1380 earthquakes were performed, located through the three-component single-station methodology (Roberts *et al.*, 1989) as implemented in the SEISAN software (Ottemöller *et al.*, 2012). The period between October 2000 to December 2005 was investigated. The practice of evaluating earthquake epicenters at the Council for Geoscience (CGS) with the single-station method was introduced following reports of an increase in felt earthquake activity in the town of Ceres (Western Cape Province, South Africa), during the last quarter of 2000. The apparent increase in seismicity coincided with a period when the availability of SANSN stations was intermittent. There was a major technical upgrade of the SANSN in the period 2001 to 2004. The aim was to replace analogue equipment with digital recorders and vertical seismometers with triaxial sensors.

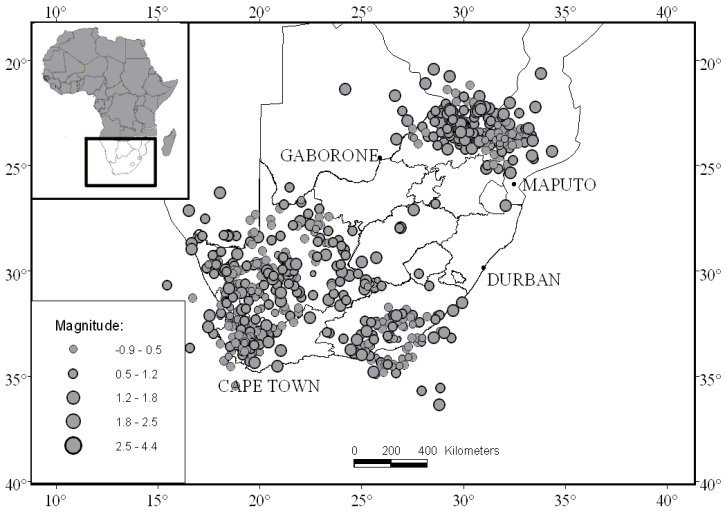

Figure: Study area and single station location events investigated.

Methodology

The locations were reviewed using a structured approach of events located with the single-station method. Firstly, a visual inspection was performed to identify the waveform quality and to determine whether the primary and secondary phase onsets were reasonably identified. In many instances the waveform quality precluded easily identifying phases onsets.

Therefore the Amplitude Signal-to-Noise Ratio (ASNR) was used to determine whether the signal could be reasonably be detected above ambient noise. An ASNR≥1.5 (Diehl and Kissling , 2007) was accepted to observe the signal above noise.

During the following phase, waveform data recorded by the International Monitoring Stations (IMS) of the Incorporated Research Institutes for Seismology (IRIS) were obtained. The primary and secondary phases identified on these waveforms were then used in conjunction with the existing phase readings to obtain epicentral solutions. The HYPOCENTER software (Lienert and Havskov, 1995) was used to determine epicentral solutions with the least squares iterative method (Geiger , 1912).

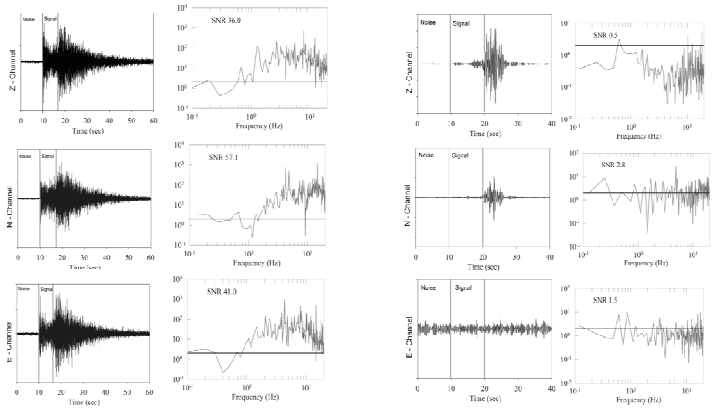

Figure: Examples of waveforms examined during the visual inspection. The ASNR were determined around the P-arrival as provided in the SANSD; the horizontal line denotes a ratio of 1.5.

Phase readings from at least three stations were available. The velocity models of both Gane (1956) and Wright (2002) were considered during the location procedure. Epicentral solutions where the Root Mean Square (RMS) of travel time residuals exceeded 2 seconds were rejected and included in the database as raw data.

Magnitudes determined during this study were determined from the maximum amplitude of the *S-Lg* selected using the SEISAN software (Ottemöller *et al.*, 2012). The calibrated local magnitude (Saunders *et al.*, 2013) was adopted for uniformity.

Results

A total of 110 seismic events were confirmed and, of which 47 could be attributed mining related activity; the remaining 63 events were of a tectonic nature.

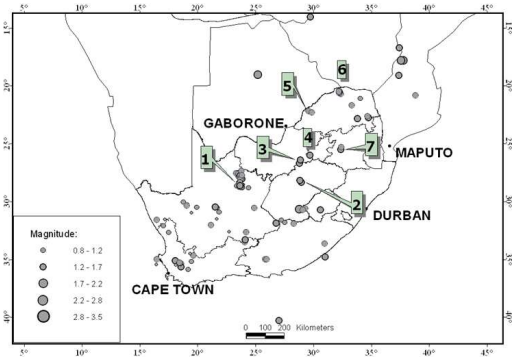

Figure: Relocated epicentres resulting from this study. The mining areas is indicated numerically:1) Lime Acres/Sishen/Kalahari mines 2) Free state gold mines 3) Klerksdorp gold mines 4) Rand gold mines 5) Grootegeluk coal mine 6) Venetia mine 7) Witbank/Highveld coal field.

Acknowledgements:

Ian Saunders would like to thank AEON, Inkaba yeAfrica, the CGS, and his supervisors Dr. Stoffel Fourie and Dr. Maartin Brandt.

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