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**Council for Geoscience
Applied Geoscience Solutions**

CGS Reference: Makause Informal Settlement
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No. of Pages: 7

23 November 2016

Department of Mineral Resources
Republic of South Africa
Private Bag X59
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0007

Attention: Directorate: Mine Closure
Mr. Reuben Masenya

Email: reuben.masenya@dmr.org.za

CC Pilusa P. Mashamaite

Email: Pilusa.Mashamaite@ekurhuleni.gov.za

Dear Sir,

SINKHOLE INSPECTION LETTER REPORT AND RECOMMENDATIONS

The Council for Geoscience (CGS) was contacted by Pilusa Mashamaite of Ekurhuleni Metropolitan Municipality on the 14th of November regarding a recent sinkhole that occurred at Makause Informal Settlement in Primrose, Johannesburg.

Subsequently, CGS personnel (Messrs Nxumalo and Matshusa) visited the site on the 17th of November 2016 for sinkhole inspection. The purpose of this letter report is to present;

- some previous investigation findings,
- recent sinkhole inspection and
- make recommendations.

Site Location and Description

Makause Informal Settlement is located on the eastern portion of the old Primrose Gold Mines Limited. The site is bounded by Pretoria Road to the north, Shamrock Road to the west, Main Reef Road to the south and Stanley Street to the east. The area of interest is accessible via Pretoria Road from the municipal fire station (Figure 1).

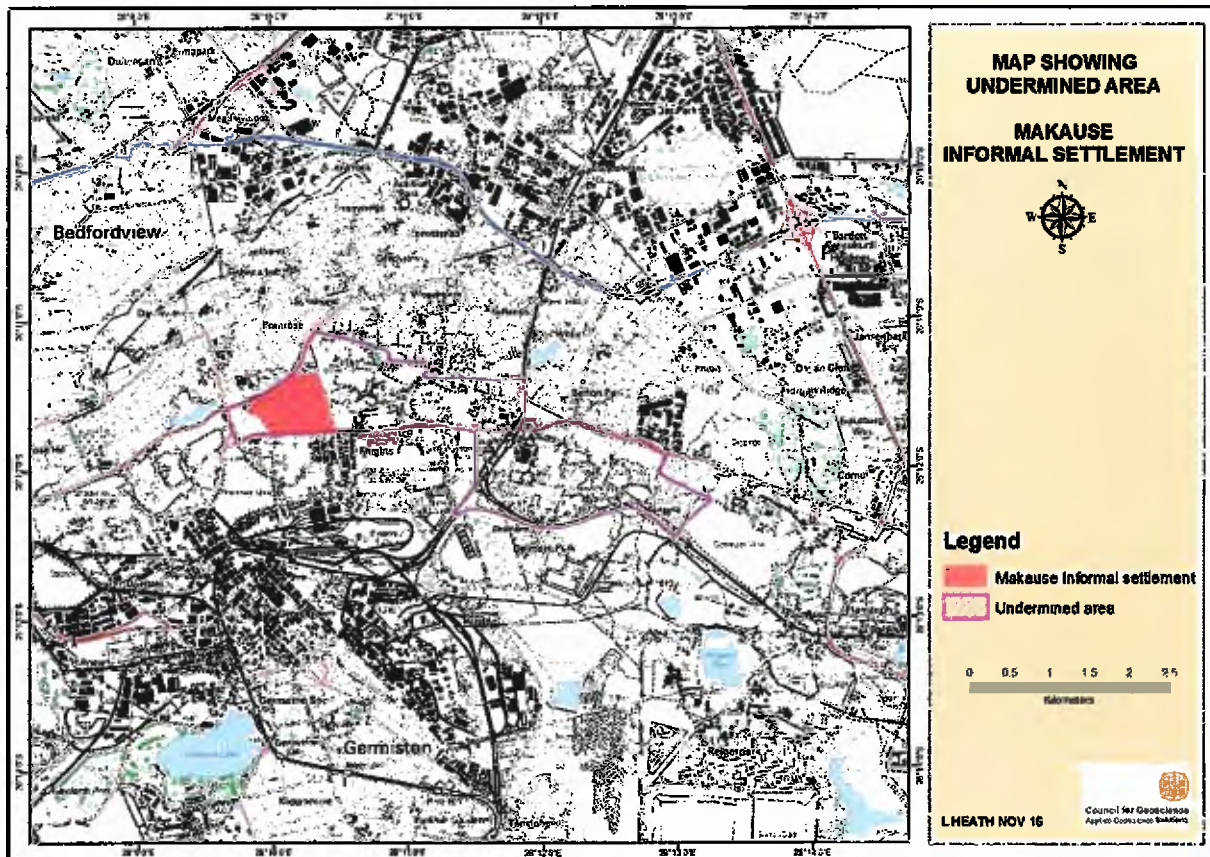


Figure 1: Site location.

The site is an informal settlement densely populated with a large number of shack dwellers. Topographically, the surface elevation is variable across the site due to the excavations created during mining and later reworking of tailings as fill material used by the residents. The reworked fill material (e.g. mining waste, domestic refuse, building rubble, ash with bottles) on the site appears to have further disturbed the upper soil horizons. According to previous studies done by Council for Geoscience (Diop and Chirenje, 2010), the western portion of the site has seven (7) mine shafts (Figure 2).

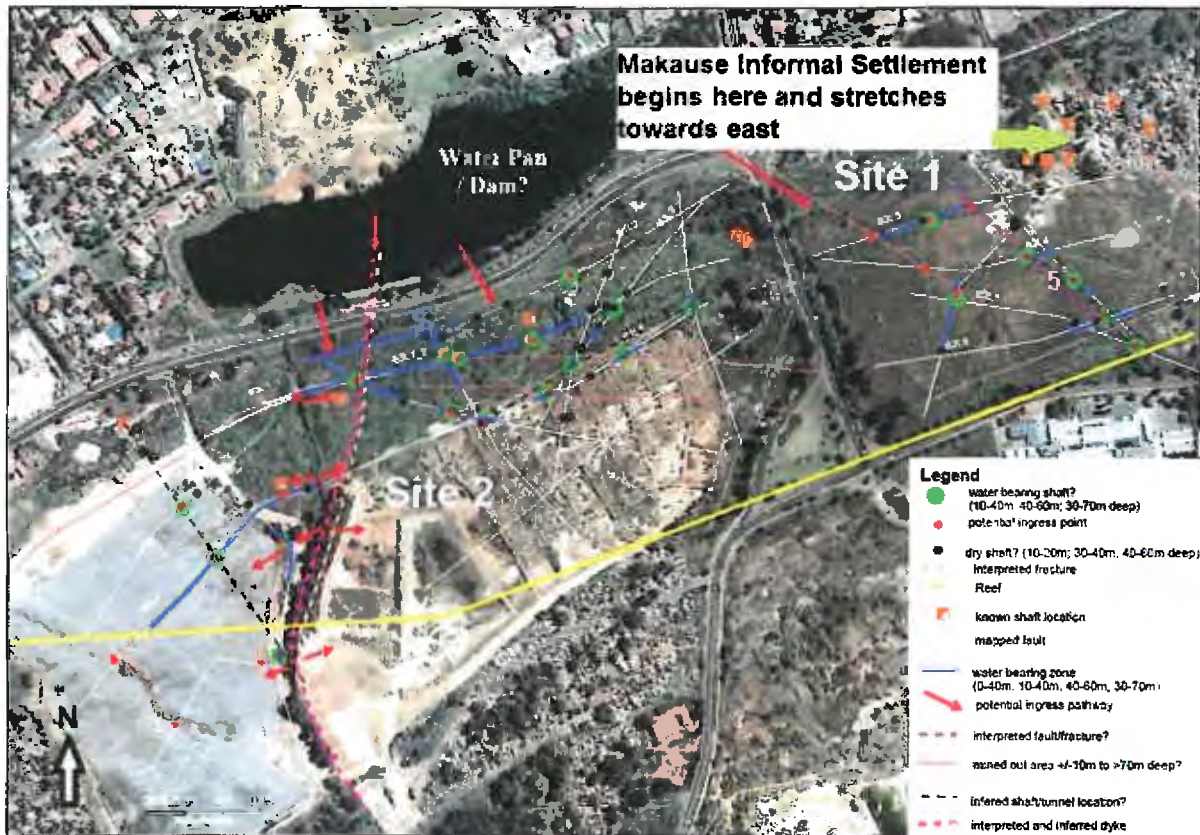


Figure 2: Known Mine Shaft location in close proximity of the site (Adapted from Diop and Chirenje, 2010).

Available Information

CGS report titled "Detection of Abandoned Mineshafts and Related Shallow Undermining Using Electrical Resistivity Tomography Final Report", dated March 2010 compiled by S. Diop and E. Chirenje.

Geology

According to available information, the site is underlain by the Johannesburg and Jeppestown Subgroups of the Witwatersrand Supergroup, with an east-west strike and dips steepening from 10° to 30° southwards. The Witwatersrand Supergroup represents a dominantly siliciclastic sedimentary succession with a cumulative thickness of 11000 m. The lower West Rand Group (3060±2 Ma) and the upper Central Rand Group (2909±3 Ma) are both composed of quartzites and shales, with the intercalated gold-bearing reef conglomerates.

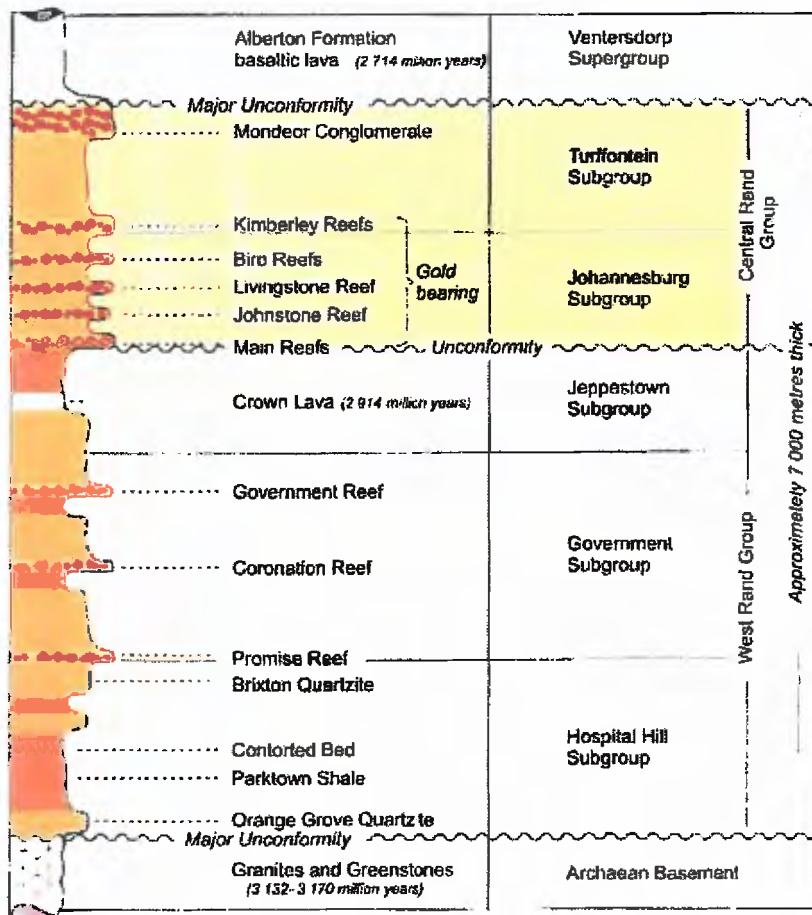
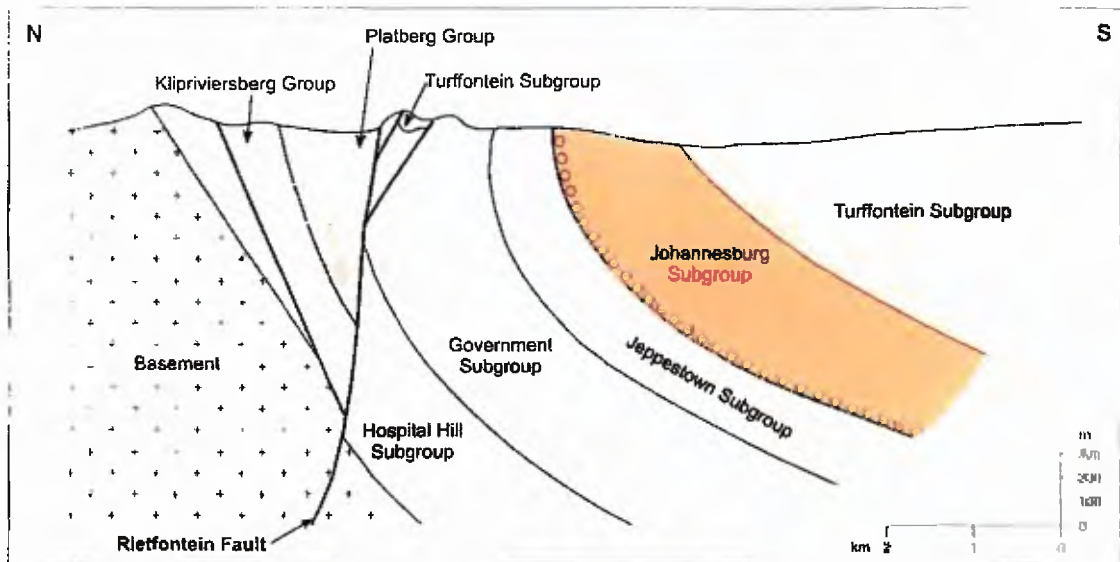


Figure 3: Witwatersand Supergroup: (a) N-S section; (b) stratigraphic column.

The Johannesburg Subgroup consists of quartzites and conglomerates of the Main Conglomerate Formation (MCF) with a few intrusive diabase sills and dykes whereas the Jeppestown Subgroup includes a variety of rock types, ranging from conglomerate, alternating beds of arenaceous shales, iron-formation and argillaceous quartzites. These sediments strike east-west and dip to the south at approximately 28° (figure 4). The bedrock is overlain by gravelly silty sand derived from and residuum of the conglomerates and quartzites, and sandy silts residuum derived from the dolerite.

The Main Conglomerate Formation (MCF) contains the Main Reef-Main Reef Leader-South Reef suite of conglomerate bands that have been mined out in the area leaving partly supported tabular shaped voids, which have been back filled in parts.

Previous Investigation Findings

During previous studies by CGS, a geophysical method (Resistivity) and percussion drilling was conducted on the site. During this exercise, nine (9) percussion boreholes were drilled on the south western portion the site (site 1 & 2 on figure 2). Eight out of the nine boreholes encountered a horizon of various fill material overlying weathered shale or quartzite at depths ranging from 2 m to 7 m below surface. The fill material ranged from loose mine waste sand to domestic refuse and building rubble. However, no fill was observed in the borehole PRIM 05, which was drilled directly into highly to moderately weathered quartzite.

Although voids were only intersected in borehole PRIM 03, the loss of air and rapid penetration of the drill rods in PRIM 06, PRIM 07 and PRIM 08 suggest the distinct probability that stopes in these areas were backfilled with material that has loosen up with time.

Current Sinkhole Inspection

The CGS team including Engineering Competency personnel visited the site for sinkhole inspection and field walkover. The sinkhole was inspected by observations and a number of pictures and coordinates were taken from the field.

During sinkhole inspections, it was noted that the top soil horizon is characterized by collapsible soils which had progressively collapsed into an old underground/near surface mine hole. The sinkhole is approximately 10 m x 6 m wide and 7 m deep (Figure 3). Fortunately enough, the structures in close proximity of the sinkhole were not affected. No injury or loss of life was recorded in the incident.



Figure 4: Sinkhole between the shacks in Makause Informal Settlement.

The soils above the underground hole comprised of dark brownish black “loose, unconsolidated” fill material of about 2.5 m underlain by orange brown sandy silty clay believed to be highly weathered shale residuum (approximately 1.8 m), which in turn is underlain by what appeared to be light orange brown, highly weathered quartzite of the

Witwatersrand Supergroup. The stability of the soils above the underground hole/opening appeared to have been affected by the introduction of water due to heavy rainfall. It is therefore assumed that the sinkhole was triggered by water ingress. This was deduced from field observations as only the uncovered part (area with not structures on it) of the area was affected. In close proximity of the sinkhole is the previous sinkhole which has been filled up with rubble materials. Land subsidence was also noted closer to one of the shack about 20 m south-east of the sinkhole.

Conclusions

The information gathered from the residents and the City Council representative is worth to note. It was gathered that there has been a number of sinkhole and subsidence formation in the area.

The geophysical work done by CGS revealed that a large portion of the site is characterized by shallow (± 8 m) underground mine holes which provides room for the top soils to collapse into, especially during rainy season. The susceptibility of top soils to collapse due to water ingress also poses a high hazard risk to structures on site. This is due to the loose and unconsolidated nature of the top soils.

Therefore, based on the previous investigations, reported number of sinkhole and subsidence that has formed on site, one can conclude that the site is highly unstable and inhabitable. No permanent structures can be constructed on the site.

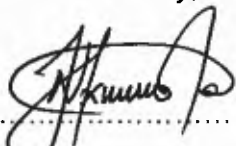
Immediate Action and Recommendations

It is therefore recommended that people living in this informal settlement are relocated as an immediate response.

However, the site may be considered for waste disposal in accordance with SANS 10234.

If you have any further queries, please do not hesitate to contact this office.

Yours faithfully,



N. Nxumalo, BSc. Hons(UKZN), Cand Sci.Nat, Cand SAIEG



Reviewed by: SG Chiliza, MSc(UKZN), Pr.Sci.Nat, MSAIEG