Chapter 14
Case Study: Geophysical Investigations of Alleged Quarry Blast Damage to Buildings in Lokgwabe Village

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ABSTRACT

A geophysical survey was carried out in 2012 to map the subsurface geology at a quarry and the village to determine if an alleged damage to houses could have been caused by blasting activity in the quarry. The survey included seismic refraction and reflection recorded with the same spread at source and receiver spacing of 2 m, 3 m, and 5 m. The signal source was a 28-lb. sledge hammer stacked 10 times to increase the S/N. Ground penetrating radar (GPR) was also recorded at a trace spacing of 0.3 m to provide detailed images of the subsurface near the damaged buildings using a 50 MHz unshielded antenna. The seismic refraction and reflection profiles show that the village is underlain by 0-4 m of loose sand, 4-10 m of fractured calcrete, and up to 50 m of fractured silcrete, with the groundwater table at 10-15 m. The GPR images show that the damaged houses sit on thick sand, which cushions them against severe ground vibration. The houses were found to have suffered more damage on the superstructure and this is possibly due to ground vibration amplification at low frequencies of 30-40 Hz.

INTRODUCTION

Synohydro Botswana, the contractor in the Kang-Hukuntsi road project, operates an aggregate quarry in a small pan ~1 km north of Lokgwabe village, which is 20 km south of Hukuntsi. The quarry has been in operation since October 2010. It mines a 4 m section composed of 2 m soft boulder calcrete at the top and 2 m of massive semi-consolidated calcrete, both of which rest over a massive silcrete at a depth of 4 m. The mining operation has currently reached a depth of 10 m, which coincides with the water table.

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The presence of groundwater in the quarry restricts the mining depth since it requires the use of water resistant explosive which will pose a pollution risk. On the other hand, mining at very shallow depth leads to minimal stemming of the blast holes and thereby increases environmental risks of damage to property and excessive noise during blasting. The project requirements favor the use of silcrete for road surfacing due to its hardness, and since it is not rippable by earth moving equipment, it requires the use of explosives to liberate the required tonnage. Blasting activities in the quarry have recently led to complaints from the residents of Lokgwabe to the effect that ground vibrations, fly rock, blast fumes, and excessive noise related to the mining activity cause damage to their houses and other property and pose a health and injury risks.

The houses that are allegedly damaged comprise mostly cement brick work and plaster, while others have clay brick improvements on the front. The reported damage includes the development of cracks propagating on the walls from wall plate downwards to the lower level of the windows, cracks on the floor, broken window panes, plaster peeling off the brickwork, and excessive shaking of the ceiling. In one case the ceiling is reported to have fallen off the brandering (Figure 1). A wooden door frame is also reported to have shaken off the wall at one of the houses. Although most house-holds in Lokgwabe

Figure 1. Photographs showing the damage reported on some of the Lokgwabe buildings