1 Introduction

1.1 Background

Any development on land underlain by dolomite presents a challenge due to the possibility that natural dolomitic instability (Karst attributes) could be exacerbated by such development. A total of 5 – 10 % of South Africa and approximately 25% of Gauteng, as well as parts of Mpumalanga, Limpopo, Northern Cape and North West Province are underlain by dolomite. It is estimated that as much as 96% of all sinkholes and subsidences that have occurred to date in these areas were man-induced. As a result, intervention through an integrated, comprehensive and pro-active dolomite risk management strategy, will serve to reduce the incidences of sinkhole formation and related losses and dangers, by reducing the likelihood of water gaining entry into the subsurface profile or uncontrolled de-watering of the dolomite aquifer occurring (SANS, 2011).

Constitutionally, the government bears primary accountability for disaster risk management as stated in schedule 4 of the Constitution of the Republic of South Africa, Act No. 108 of 1996. However, although political commitment and legal requirements are in place, the current official procedures dealing with development on dolomite are not in all cases adequate to mitigate associated risks. A Dolomite Risk Management Strategy (DRMS) is therefore needed as:

- people are in need of protection and dolomite poses a risk to life and property,
- the risk of sinkholes or subsidence is difficult to quantify,
- municipal or urban development has been shown to have a negative impact on stability in a dolomitic environment,
- every local authority is required to have a risk management strategy according to the Constitution and by SANS (2011), dolomitic areas should form part of such a strategy.

There is an unacceptable risk, chance, uncertainty and unpredictability to what can occur if there is no dolomitic strategy in place, as several incidents in South Africa have vividly demonstrated.

AGES (Pty) Ltd was appointed by the Tlokwe City Council to develop a strategy to manage the risk related to dolomite within its jurisdiction (Council Resolution C122/2012-06-19, MM Resolution 75/2009-05-09, Council Resolution C120/2010-06-09, Council Resolution 244/2011-11-29, MM Resolution163/2011-11-22). The purpose is to quantify the risk and propose mitigatory steps in order to minimise the development of sinkholes and subsidence that can lead to loss of life and severe damage to buildings and infrastructure. This thesis is deemed essential for the development of such a strategy and forms an integral part of the technical reports rendered by AGES (Pty) Ltd. The following reports were compiled in conjunction with the compilation of this dissertation:

- Volume 1: Geo-Environmental assessment of dolomitic land in Potchefstroom in preparation of the development of a regional dolomite risk management strategy. Report no: 2010/05/03 DSA (AGES, 2010a)

- Volume 2: Preliminary Regional Dolomite Risk Management Plan for Potchefstroom: Framework for Implementation. Report No. 2010-05-03 DSA (AGES 2010b)

- Dolomite Risk Management Strategy: Strategic Planner 2011. Report Number 2011-10-08 DRMS. (AGES, 2011)

- Dolomite stability investigation in Tlokwe City Council, North West Province. Report no: 2012/04/06 DSI (AGES, 2012a)

- Tlokwe City Council: Geohydrological assessment of the Tlokwe Dolomite, Potchefstroom area. Report no. 2011/04/08 GWSA (AGES, 2012b)

- Tlokwe dolomite social awareness strategy proposal. Report no. AS-R-2012-08-13 (AGES, 2012c)

1.2 Problem statement

The question to be addressed in this dissertation is: What disciplines and methodologies need to be included in a DRMS for the Tlokwe City Council?

1.3 Research objectives

In order to develop the methodology towards the definition of a DRMS, the following research objectives need to be addressed:

1. What geological, geohydrological and geotechnical conditions determine the stability of dolomite?

2. What other factors are playing a role and how can all factors and conditions be reflected in a risk zone classification and identification of priority focus areas?

3. What research and management actions need to be included in the DRMS?

4. What social awareness is needed to optimise research and management actions?

1.4 Risk associated with urban development on dolomite

Dolomite is a rock composed of calcium-magnesium carbonate sediments with a distinctive "elephant skin" texture. Due to this chemical composition, it dissolves more easily in water and acidic water than other rock types. The dissolving process usually takes millions of years, and depends on the strength of the acid and time of exposure. The natural process can be accelerated by human activities. This may cause caves or underground cavities to form in areas underlain by dolomite formations. The soil overlaying these cavities can collapse to form either a sinkhole or doline (Council for Geoscience, 2010).

Dolomite can be classified as a type of carbonated bedrock and is highly vulnerable to the effects of water infiltration (Kochanov, 1999). Rain water and water from insufficient and lacking plumbing networks infiltrate dolomite rock formation thereby loosening the sediment throughout time. Continuous loss of sediment leads to the development of cavities within the soil.

With sustained water permeation these cavities start to move to the surface. As these cavities get nearer to the surface, the roof of the cavities cannot support it, they break down and form what can be identified as a sinkhole.

A sinkhole is a feature that occurs suddenly and manifests itself as a hole in the ground. A classification of sinkholes in terms of size is proposed by Buttrick & Van Schalkwyk (1995).

Sinkholes can be very catastrophic due to their sudden occurrence and may cause loss of life and/or damage to property. There has been 39 known sinkhole related deaths in South Africa in the last 50 years. An estimated cost of damage to date is believed to be greater than R1.3 billion. The typical cost to repair a sinkhole (excluding structural damage) is usually around R200 000 (Council for Geoscience, 2010).

Sinkholes and subsidences can be formed by water infiltration into the ground e.g. from leaking water pipelines, sewers, storm water canals, pipes, etc. The artificial lowering of groundwater (dewatering) by mining or farming activity is one of the most dangerous mechanisms for sinkhole formation, seeing as this happens in highly populated areas. Sinkholes do occur naturally, but about 96% of sinkholes are man-induced (Merafong City Local Municipality, 2008).