CHAPTER 1

INTRODUCTION

1.0 Location of Project Areas

The study primarily encompasses much of Eastern Zimbabwe, including the entire Umkondo group and the underlying Zimbabwe Archean Basement, stretching from Chipinge, in the south, to Nyanga in the north (Fig. 1.1). An area of about 165 km^2, situated some 30 km northwest of Chimanimani town, was selected for detailed mapping (between U.T.M. grid lines 450000 and 466000 east, and 7830000 and 7841000 north). The project also involved sampling Umkondo dolerites and members of the Mutare, Guruve and Kamativi dyke swarms of Wilson *et al.* (1987), which have been cited in literature to be presumably of Umkondo age (Wilson *et al., 1987*; Hanson *et al.*, 1998b), i.e. c. 1100 Ma, for precise U-Pb zircon/baddeleyite geochronology. Samples of Umkondo dolerites and Mutare dykes were collected from four districts in Eastern Zimbabwe; namely Chipinge, Chimanimani, Mutare and Nyanga (Figs. 1.2-1.7). The second area of study occurs in the vicinity of Chinhoyi (Fig. 1.8), where the Guruve dykes were sampled. The Guruve dykes occur in the northern part of the Zimbabwe craton and west of the Great Dyke. The third area of study is situated in the Dett area in western Zimbabwe (Fig. 1.9), where the Kamativi dykes crop out.

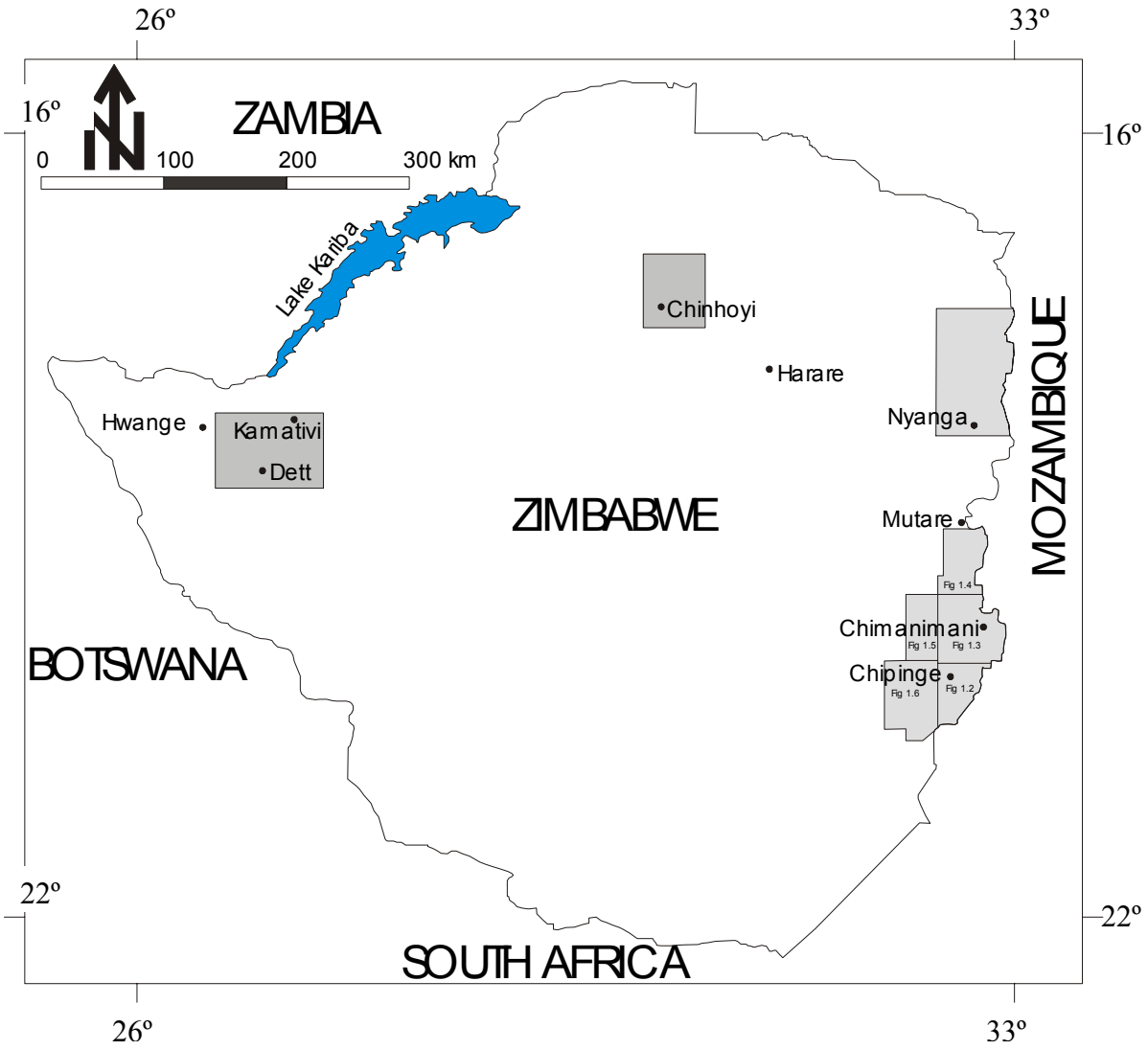

Fig. 1.1. Location map showing the areas of study in eastern Zimbabwe, Chinhoyi and Hwange.

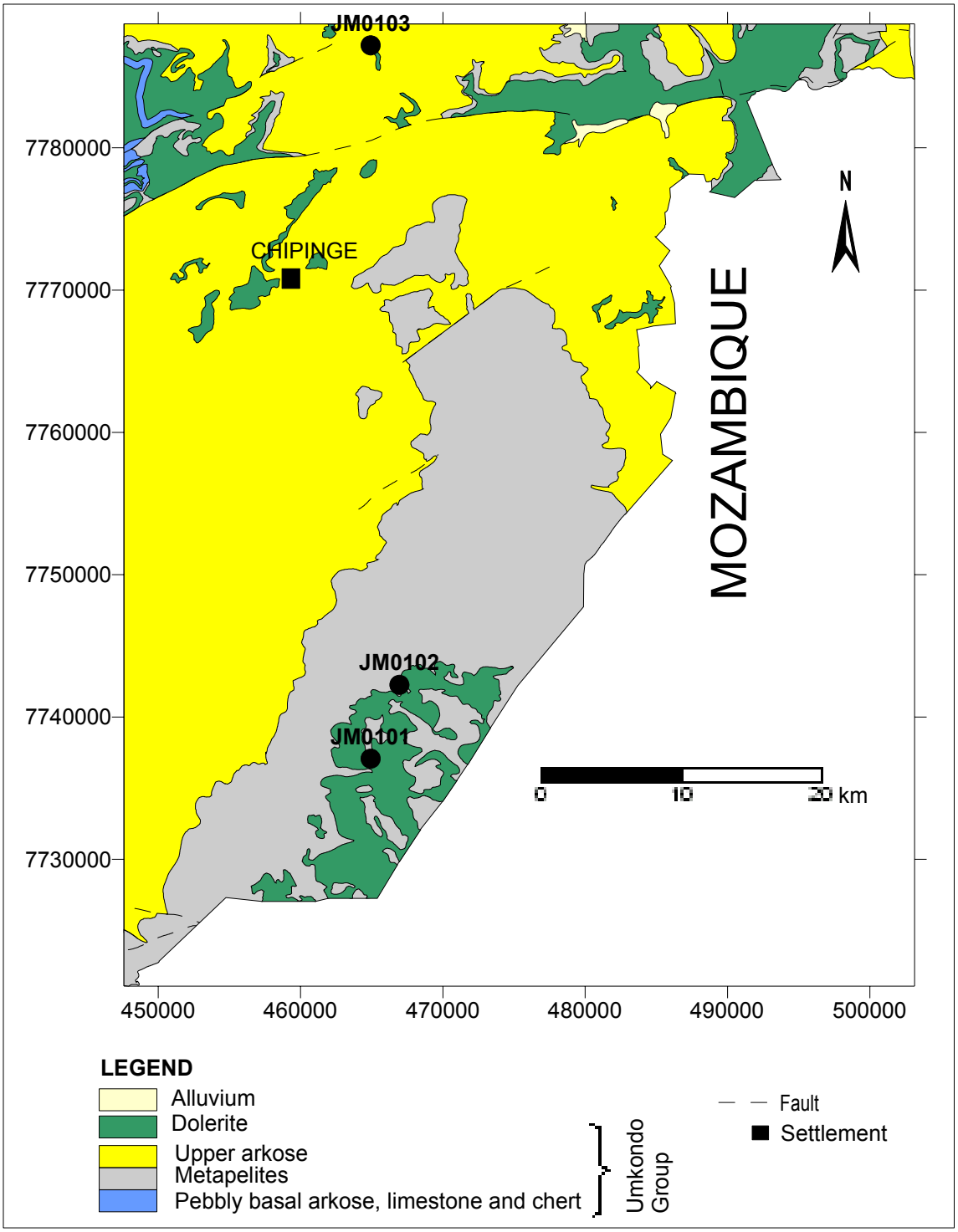

Fig. 1.2. The geology of the area around Chipinge showing Umkondo dolerite sills that intruded rocks of the Umkondo group. The dots represent the sampling sites. Modified after Watson (1969).

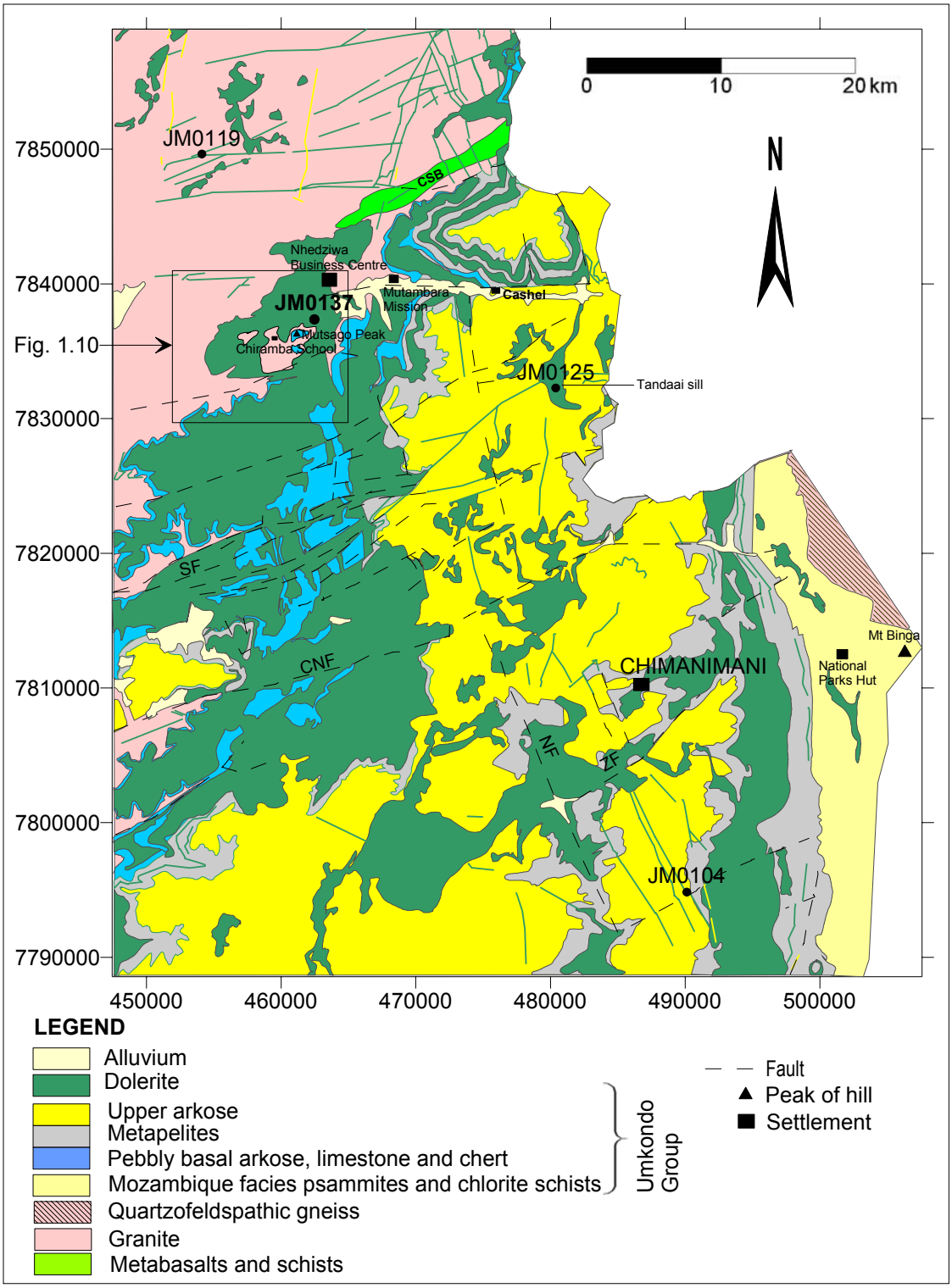

Fig. 1.3. The geology of the Chimanimani area showing dolerite dykes and Umkondo sills that intruded rocks of the Zimbabwe facies of the Umkondo group. Dolerites are rare in the Mozambique facies of the Umkondo group. The dots represent the sampling sites. CSB = Cronley Schist Belt CNF = Chikwezi-Nyanyadzi fault, SF = Shinja fault, ZF = Zunguni fault, NF = Nyahodi fault. Modified after Watson (1969).

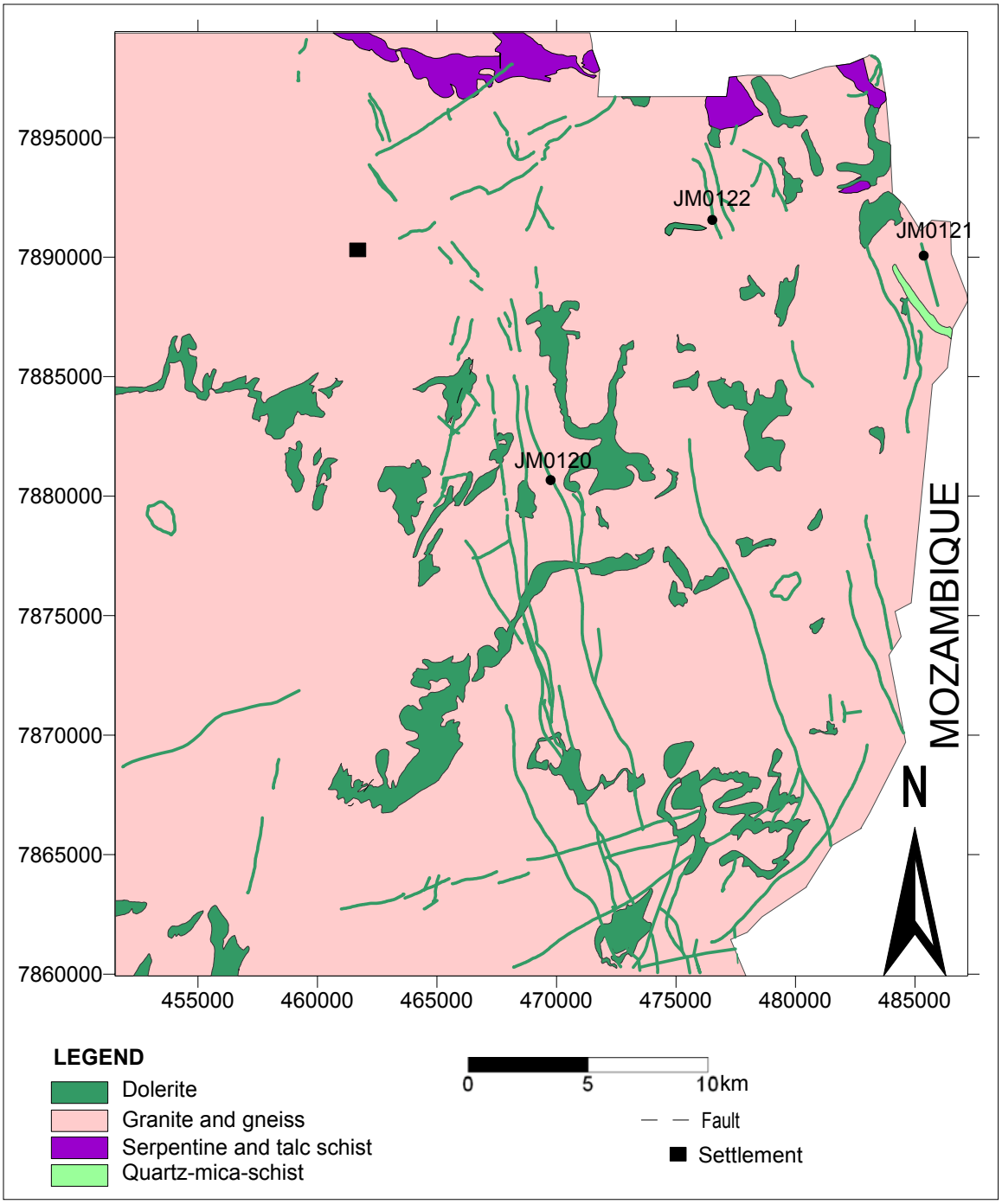

Fig. 1.4. The geology of the area south of Mutare. The north northwest trending dykes represent the Mutare dykes. The dots represent the sampling sites. Modified after Watson (1962).

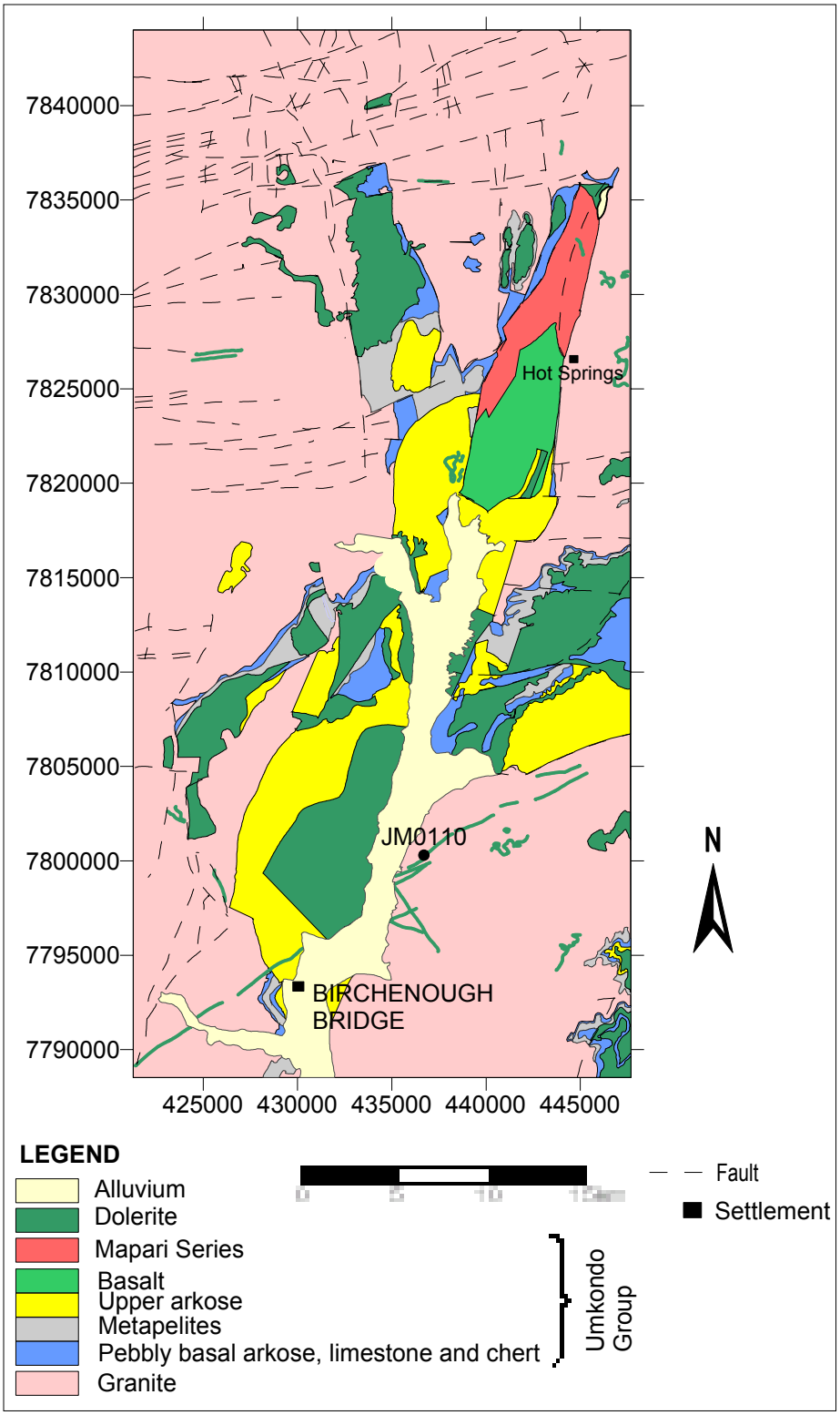

Fig. 1.5. The geology of the Middle Sabi area. Dolerites of presumably Umkondo age intrude Archean Basement granites and metasedimentary rocks of the Umkondo group. Dots represent the sampling sites. Modified after Swift (1962).

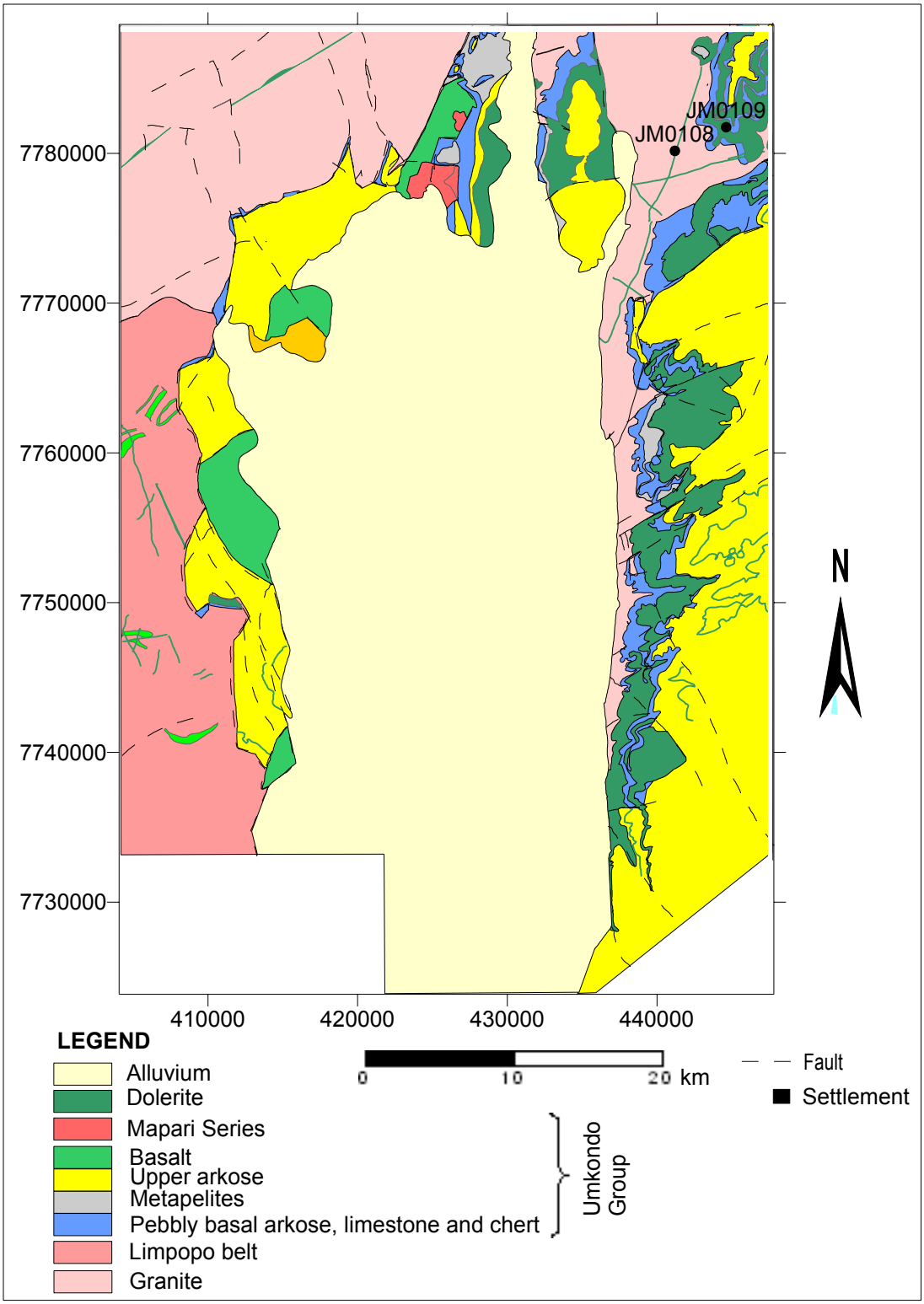

Fig. 1.6. The geology of the Middle Sabi Valley area. Rocks of the Umkondo group overlie Archean Basement granites and granulites of the Limpopo Belt. Dots represent the sampling sites. The Limpopo belt extends eastwards into Mozambique (Jelsma, personal communication). Modified after Swift (1962).

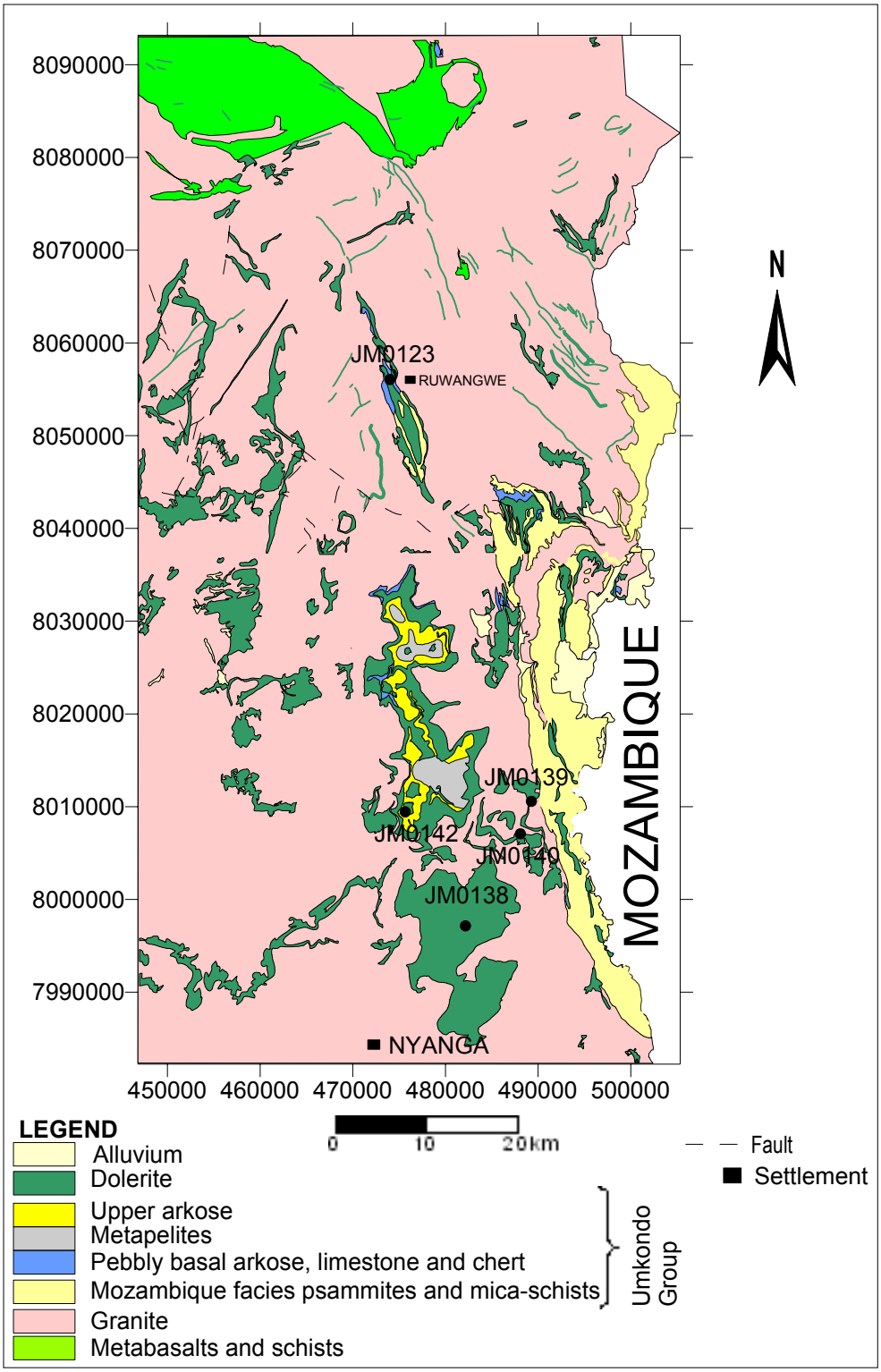

Fig. 1.7. The geology of the Nyanga area showing dolerite sills and dykes that intruded the Archean Basement granites and gneisses. Sills also intruded rocks of the Umkondo group. Dots represent the sampling sites. Modified after Stocklmayer (1978).

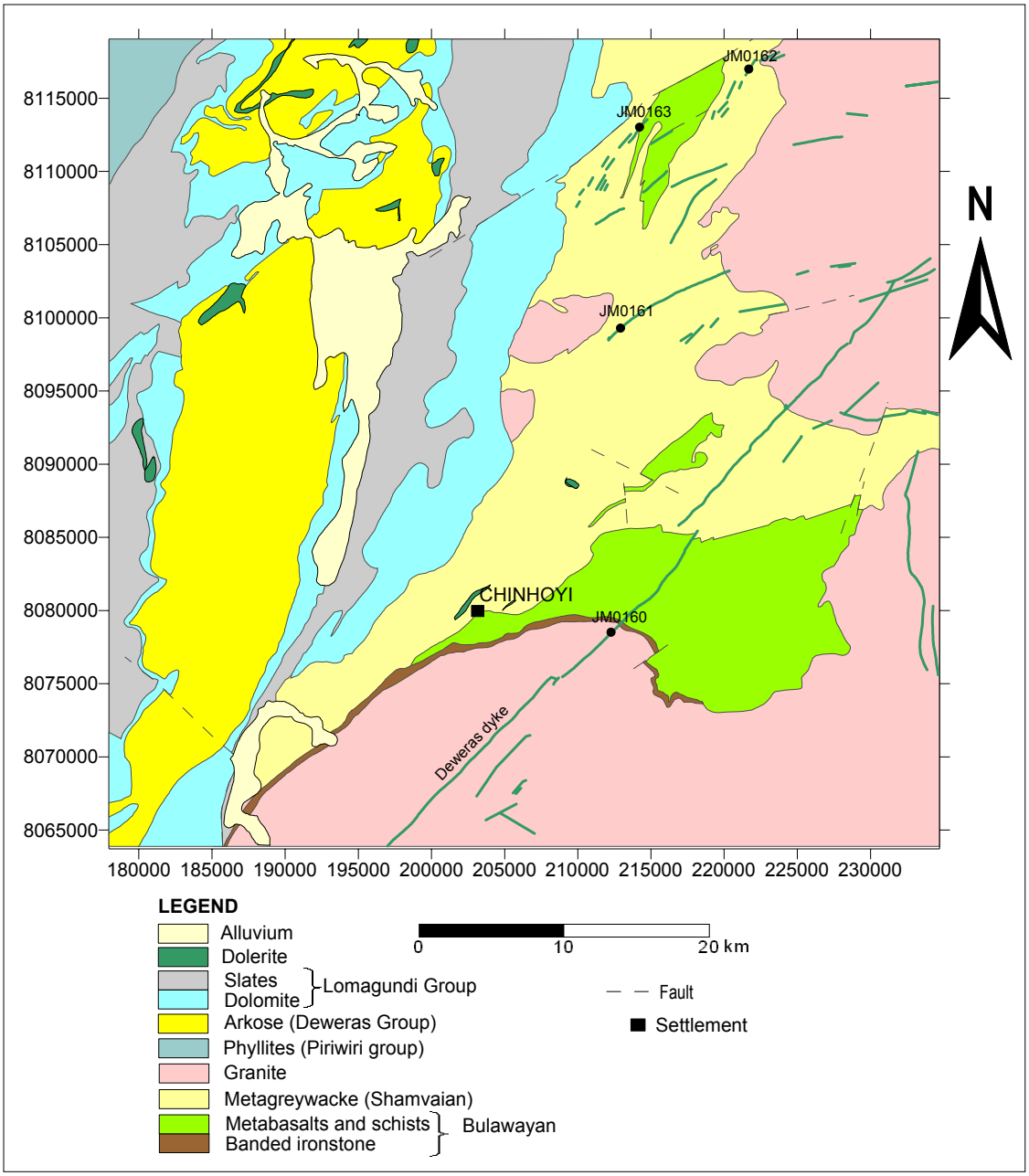

Fig. 1.8. The geology of the area around Chinhoyi showing the northeast trending Guruve dykes. The sampling points are shown by dots. Modified after Stagman (1961)

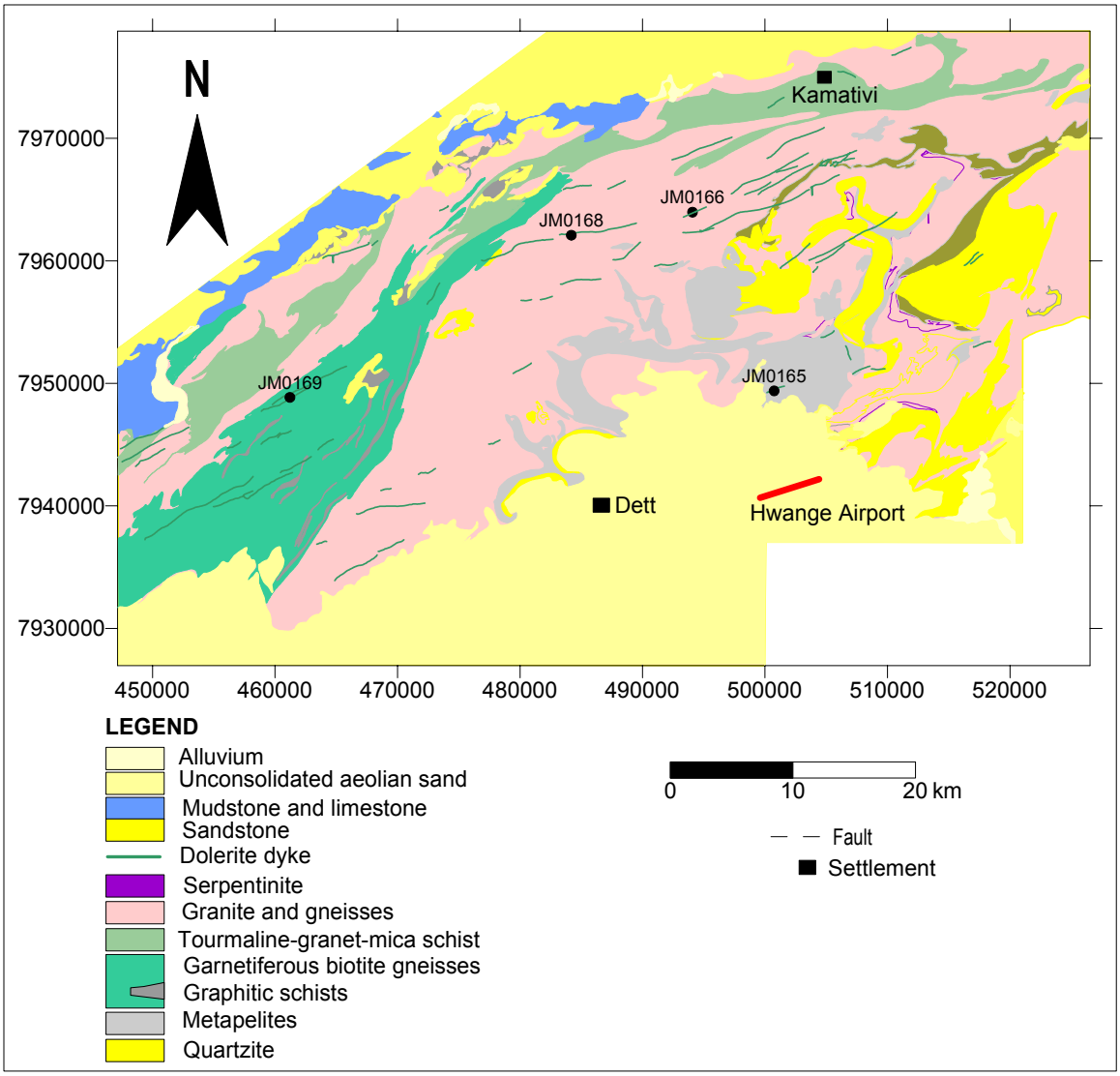

Fig. 1.9. The geology of the Dett area showing the Kamativi dykes that trend northeast. Sampling points are represented by dots. Modified after Lockett (1979).

1.1 Problem Definition and Justification of Study

The Umkondo igneous province encompasses a large part of southern Africa where apparently related, predominantly mafic igneous rocks of Neopreoterozoic age occur (Hanson *et al.*, 1998b). Understanding the Umkondo igneous province is critical to reconstructions of Rodinia and to concepts of supercontinent dispersal and assembly at c. 1100 Ma (Hanson *et al.*, 1998b). The research is part of a larger project that involves palaeomagnetic and geochronological studies of the Umkondo igneous province throughout southern Africa. For palaeomagnetic studies of Umkondo dolerites it is vital

to understand the tectonic history of the Umkondo group since the palaeomagnetic pole directions acquired at the time of emplacement may have been changed during subsequent deformation. It is therefore necessary to establish whether the Umkondo group is autochthonous or not, which is determined by the nature of the contact (unconformable or tectonic?) between the Umkondo group and the Archean Basement.

The nature of the contact between the Zimbabwe facies of the Umkondo group and the Archean Basement has recently been a subject of controversy. The original idea of a simple non-conformity (Watson, 1969; Stocklmayer, 1978) has been recently challenged by suggestions that the entire Umkondo group may be allochtonous (Dirks, personal communication, 1999). Geological field mapping is therefore necessary and can provide a basis for further geochronological work, palaeomagnetic studies and palaeo-stress analysis using dykes. The relative ages of the dykes and deposition of the Umkondo Group is inferred from one locality where the dykes intruded wet sediments (Hanson *et al.*, 1998b) in which an approximately 4 m-wide zone comprises dolerite fragments intermingled with fragments of the upper arkose unit. The relative age relationships between the dolerites and the metasedimentary rocks of the Zimbabwe facies need to be satisfactorily established through field mapping.

Umkondo dolerites have a regional significance, but precise age data are lacking. Most of the available geochronological data is based on the Rb-Sr and K-Ar methods (Cahen *et al.*, 1984; Allsopp *et al.*, 1989; Cheney *et al.*, 1990) of dating, the interpretations of which are problematic in ancient mafic rocks. Rb and Sr are relatively mobile elements such that the Rb-Sr system may be sensitive to weathering, hydrothermal alteration and low-grade metamorphism (Rollinson, 1993). Umkondo dolerites and the Mutare, Guruve and Kamativi dyke swarms of Wilson *et al.*, (1987) have suffered low-grade metamorphism and hydrothermal alteration, which suggests that the Rb-Sr method could be problematic. These facts necessitate the application of the U-Pb zircon/baddeleyite dating technique, which is insensitive to low-grade metamorphism since zircon has a blocking temperature of about 1000°C (van Breemen *et al.*, 1979; Cliff, 1985). Correlation of the Umkondo

dolerites with other igneous provinces can be made based on U-Pb zircon dates and mapping results.

Although two U-Pb ages have been published recently (Hanson *et al.*, 1998b; Wingate, 2001) for dolerite sills that intrude the Umkondo, additional geochronological results are required to investigate if the huge volumes of sills that intrude the Umkondo group, located in different stratigraphic settings, belong to a single magmatic event. Mashonaland and Umkondo dykes cannot be distinguished in the field (Hanson *et al.*, 1998b; Munyanyiwa, 1999). The age relationships of these dykes can only reliably be established through isotopic dating using the U-Pb zircon/baddeleyite technique since they have suffered low-grade metamorphism (Munyanyiwa, 1999). The type area of the Umkondo igneous event was established in eastern Zimbabwe, and there is need to ascertain the precise age relationship of the enigmatic Mutare, Kamativi and Guruve dykes that are speculated to be possible correlatives of the Umkondo dolerites using the Ub-Pb zircon/baddeleyite technique. The classification of dyke swarms by Wilson *et al.* (1987) is largely based on geometry and spatial associations and can be revisited in the light of new geochronological and geochemical data.

1.2 Objectives of the Study

The objectives of the research project are to:

- Investigate the tectonic setting, timing, and palaeogeography of the Umkondo group, with particular emphasis on the Umkondo dolerites, and
- Relate the Umkondo group to the regional Mesoproterozoic tectonic framework.
- Investigate the age of igneous rocks that may be related to the Umkondo dolerites, i.e. the Mutare, Guruve and Deweras Dyke swarms of Wilson *et al.* (1987).

1.3 Research Methodology

- The major research methodology involved geological field mapping of an area of 176 square kilometres on a scale of 1:25000, assisted by aerial photograph interpretation (Fig. 1.10). More detailed mapping was carried out in areas of critical field relations (Fig. 1.11). The mapping exercise was done over a cumulative period of 15 weeks between May and September 2001 and 1 week in May, 2002.
- Dyke and sill intrusion mechanisms were studied in order to constrain the stress fields during the emplacement of the dolerites. A number of dykes were mapped in order to investigate the age relationships between the dykes and metasediments. Stress fields associated with dyke emplacement were constrained from a combination of theoretical considerations of dyke intrusion mechanisms and the field observations.
- Collecting dolerite dykes/sills samples for U-Pb zircon/baddeleyite geochronology. Samples were collected from Umkondo sills and dykes of the Mutare, Guruve and Kamativi swarms of Wilson *et al.* (1987) between May and September 2001. The sampling procedure and sample preparation are described in chapter 6. Laboratory work, i.e. mineral separation and conventional U-Pb zircon/baddeleyite geochronology was, done in an M.I.T., laboratory, Boston, U.S.A over a period of 2 months, i.e. from mid October to mid December, 2001.