CHAPTER 2

PROJECT MOTIVATION AND OBJECTIVES

2.1 Background and motivation

The dolomitic cave sites of South Africa have yielded one of the richest fossil records of both hominin and associated fauna in Africa. A total of nine hominin-bearing cave deposits are known in this region, referred to as The Cradle of Humankind, which lies in a 47 000-hectare valley, forty kilometres west of Johannesburg. Human activity has taken place for millions of years in and around these caves, including the earliest-known mastery of fire, and 40% of all the world's human ancestor fossils have been located here (McCarthy and Rubidge, 2005).

Sterkfontein, which is the biggest and best-known of the caves in the area, is where over 500 hominid fossils and over 9 000 stone tools have been found. It was here that two major finds were made:

- *Australopithecus africanus* (Mrs Ples), dating back 2.5-million years, and found by Robert Broom in 1947.
- Little Foot, an almost complete ape-man skeleton (*Australopithecus africanus*) that could be between 1.5 and 4 million years old, and discovered by Ron Clarke in 1995.

Coopers D is another big site only a few metres from the Sterkfontein caves dating to 1.6 million years old, and yielding fossils of *Paranthropus robustus*, described by Christine Steininger and colleagues in 2008.

Unfortunately many of the fossil bones excavated from these dolomitic cave sites in the Cradle of Humankind are covered by brownish-black coatings of manganese dioxide and to a lesser extent iron oxide. This layer obscures the fine details on the bone surface and surface modifications, making their identification difficult or impossible. This project was thus set up to establish non-invasive chemical cleaning methods for these coated fossils.

2.2 Objectives

The aims of the project:

1. Characterize the manganese oxide fossil bone coatings so as to gain a better understanding of the surface chemistry involved in the dissolution process, through the use of various analytical techniques such as powder X-ray diffraction P-XRD), Infrared (IR) spectroscopy, Raman spectroscopy, gravimetric analysis and Inductively coupled plasma optical emission spectroscopy (ICP-OES)

2) Develop, optimise and validate new chemical cleaning methods that are not invasive. These could include methods for the removal by:

   a) The use of hydrogen peroxide as a reducing agent

b) Nitrite method

c) Hydroxylamine method

d) Chromium(III) method

3) Investigate other possible chemical methods for further optimisation and validation in the future. These include:

   a) DTPA (diethylene triamine pentaacetic acid) as a complexing ligand.

   b) Catechol employed as an organic ligand.

4) Chemically remove hematite fossil bone coatings previously achieved by mechanical abrasion.

5) Investigate and compare the chemistry and removal efficiency of all optimised and validated cleaning methods.

6) Design a flow-through system for the hydrogen peroxide chemical cleaning method to optimise the amount and rate of bone fragments to be cleaned, thus allowing for simultaneous cleaning of many manganese oxide coated fossil specimens. This flow-through system would then be used, with close monitoring, in the removal of manganese oxide coatings from an entire faunal assemblage derived from the Coopers D cave site, located in the Cradle of Humankind.