Introduction: Structural, petrological and geo-
physical work [1, 2, 3], as well as numerical modeling
[4], have been conducted on the Vredefort impact
structure to understand the mechanism of rock de-
formation during crater modification of large terrestrial
impacts. In order to bridge the gap between geological
ground truth and dynamic, numerical modeling, we
aim to construct a 3D structural model of the impact
structure followed by kinematic restoration of de-
formation that leads to formation and collapse of its cen-
tral uplift.

The Vredefort Dome is the eroded remnant of a
collapsed central uplift of a Paleoproterozoic impact
structure[1]. The central part of the Dome, approxi-
mately 40 km wide, consists of Archean (>3.0 Ga)
granitoids and is surrounded by steeply dipping and
overturned sedimentary and volcanic strata of Protero-
zoic (3.0 - 2.1 Ga) age, known as the collar around the
crystalline core. To the north and west, the collar rocks
are well exposed and form a series of concentric mor-
phological quartzite ridges and valleys along less resi-
tant shale horizons around the core, whereas to the east
and the south, the central uplift is covered by the Phan-
erozoic Karoo Supergroup.

Methods: Using the software GOCAD and Geo-
Modeller (Intrepid Geophysics), we attempt to con-
struct a 3D model of the collar rocks. The modell will
include the attitude of prominent marker surfaces
(sedimentary strata and lithological interfaces) as well
as impact-induced discontinuities known from field
analysis and geophysical imaging. Exposure of pre-
impact rocks is largely limited to the northwestern
quadrant of the impact structure and will, thus, con-
strain the 3D model. The construction of a multi-
surface model from this portion of the collar will not
only involve marker surfaces but also take into account
the volume of lithological groups, e.g. the West Rand
Group (Fig. 1), in between major lithological inter-
faces. As more structural information becomes avail-
able from the field and geophysical imaging, the model
will consider also the geometry of major discontinui-
ties and local deformation on lithological interfaces.

Following construction of a 3D model, the data set
will be imported into 3DMove (Midland Valley Inc.) to
conduct further structural analyses and 3D kinematic
restoration. The first step in this procedure will be to
eliminate possible effects of post-impact deformation
by restoring displacements on post-impact faults, and
will result in the geometry of rocks attained upon the
end of the modification stage. This model will be used
to interpolate the other three quadrants to generate a
full circumferential model, on which the “dome inver-
sion tool” of 3DMove will be applied. Passive back
rotation of marker horizons and application of the
“volume tracker tool” will allow to estimate the rock
volume that was translated during central uplift forma-
tion. The tracker tool will also serve to check the plau-
sibility of the kinematic restoration.

Expected results: Although the accuracy of earth
models on a crustal scale is often limited, modern geo-
physical methods will allow to reliably image the deep
structure of the Vredefort Dome. The visualization of
structural elements as intended in this study will pro-
vide new insights into the deep structure of the Vrede-
fort Dome and into the processes associated with crater
modification of large terrestrial impacts. In particular,
an estimate of the displaced rock volume can provide
information on the relative importance of doming and
inward-directed mass transport during central uplift
formation. The correlation of the moved rock volumes
with the current deep structure of the impact structure
can also show how much material passed through the
core and is today removed by erosion.

References: [1] Reimold W. U. and Gibson R. L.
Bisschoff A. A. and Mayer J. J. (1999), Council for
Geoscience, Pretoria, Geol. Map 1:50.000.