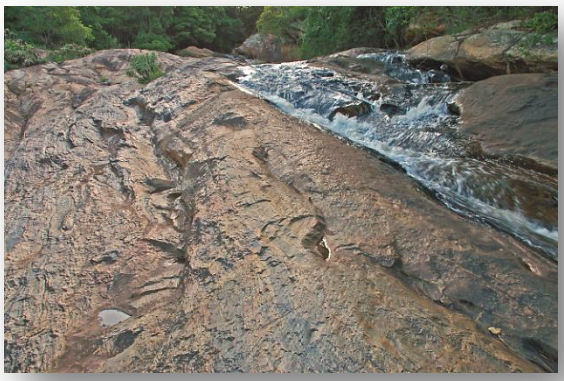
The Fascinating Geology of the Phophonyane Falls Nature Reserve

Even the common observer notices the vast range of geologic settings in southern Africa, including the flat plains of the Karoo, the windblown deserts of the Kalahari, the high mesas and sheer basalt cliffs of the Drakensberg, the inspiring mountains of the Western Cape, and the rounded peaks of the Barberton Mountainlands of South African and northern Swaziland. Through a combination of geologic mapping, rock characterization and radiometric age dating, geologists have begun to recognise that this exciting landscape represents an amalgamation of rock which record plate-tectonic process spanning over the past 3.5 billion years.

The Phophonyane Falls Nature Reserve is host to some of the oldest rocks in southern Africa, ranging in age from 3.5 billion to 3. 2 billion years old, and can therefore help geologists understand how the African continent evolved early in earth's history. Specifically, and perhaps more importantly, is that it also contains a boundary between two between two continental blocks which represent different environments within the earth's crust. This boundary, recently coined the "Phophonyane Shear Zone", runs approximately parallel to the Phophonyane River and separates the Barberton Greenstone Belt to the northwest from the Ancient Gneiss Complex to the southeast. The Barberton Greenstone Belt has held the interest of geologists for the past 40 years because it contains evidence for some of the earliest life on earth, has yielded some of the largest gold reserves in the world, and also includes some of the oldest sedimentary and volcanic rocks known, the latter of which allow on to derive information about ancient magmatic processes occurring within the interior of the planet.

The Ancient Gneiss Complex makes up a large part of northern and central Swaziland, and contains the oldest rocks in Southern Africa, dating back to about 3.55 billion years ago. These rocks are composed of granites, granodiorites, tonalites, and amphibolites, which were all molten magmas which cooled beneath the earth's surface. These rocks were subsequently deformed and mixed together on the meter-scale by tectonic processes, which is why they appear as banded light and dark layers today.

A key observation to make is that rocks from the Barberton Greenstone Belt represent geologic and biologic processes occurring at the earth's surface, whereas those from the Ancient Gneiss Complex formed deep within the earth's crust. For this reason, current geologic research on the Phophonyane Falls Nature Reserve is focused on figuring out how and when these geologic environments were juxtaposed together. The term "Phophonyane Shear Zone" is used because a shear zone is essentially a tectonic fault which occurs sufficiently deep within the Earth's crust (and with sufficient heat) such that rocks deform in a ductile manner – like toothpaste. If you look at the rocks exposed along the river bed for long enough, you will begin to see that they form planar sheets, which dip downward to the northwest at an angle of about 45 degrees. These sheets formed when rocks of the Ancient Gneiss Complex and the Barberton Greenstone Belt (the rocks exposed along the Phophonyane River are part of the Ancient Gneiss Complex) moved past one another under high pressures and temperatures such that solid rock essentially flattened into a planar fabric.



A continuing project involving geologists from the University of Cape Town and the Massachusetts Institute of Technology, USA, have utilized this information in combination with U-Pb radiometric dating to constrain both the timing and mechanisms of movement along the
Phophonyane Shear Zone (for more specific information and a list of publications on this topic go to:

http://caps.mit.edu.research/group/IGlab/kaapval.html

Such research in the Phophonyane Falls Nature Reserve is essential in constructing tectonic models for the formation of earliest fragments of the African continent and can shed light on how the Earth evolved from its molten, primordial system into the complex system that it is today.