Geology at E Unoto Retreat

As you turn off the main road that brings you from the Kilimanjaro International Airport to the little town of Mto Wa Mbo, you see our sign "E Unoto Retreat www.maasaivillage.com". Once you are on the dirt road, you see a vista of open fields, a couple of small Maasai villages, and in the distance steep, almost vertical-looking cliffs stretching across the entire horizon from left to right. You are looking at a unique geological sight of the entire world. This is a segment of escarpments formed by the *Great Rift Valley*.

More than a hundred years ago, J.W.Gregory summarized the geology of the area. Hence, the name *Gregory Escarpment*. However, in 1896, Gregory had not realized the significance of the Great Rift Valley as a modern analogue for how the continents have split apart from an original supercontinent almost 250 million years ago. In fact, the theory of *Plate Tectonics*, as it is now called, did not become established as the unifying theory in geology until the 1970s. In its framework, the geologists explain mountain building, the creation and destruction of oceans, the locations of volcanoes and earthquakes, and the creation and concentration of natural resources during almost the entire 4-billion year history of the earth.

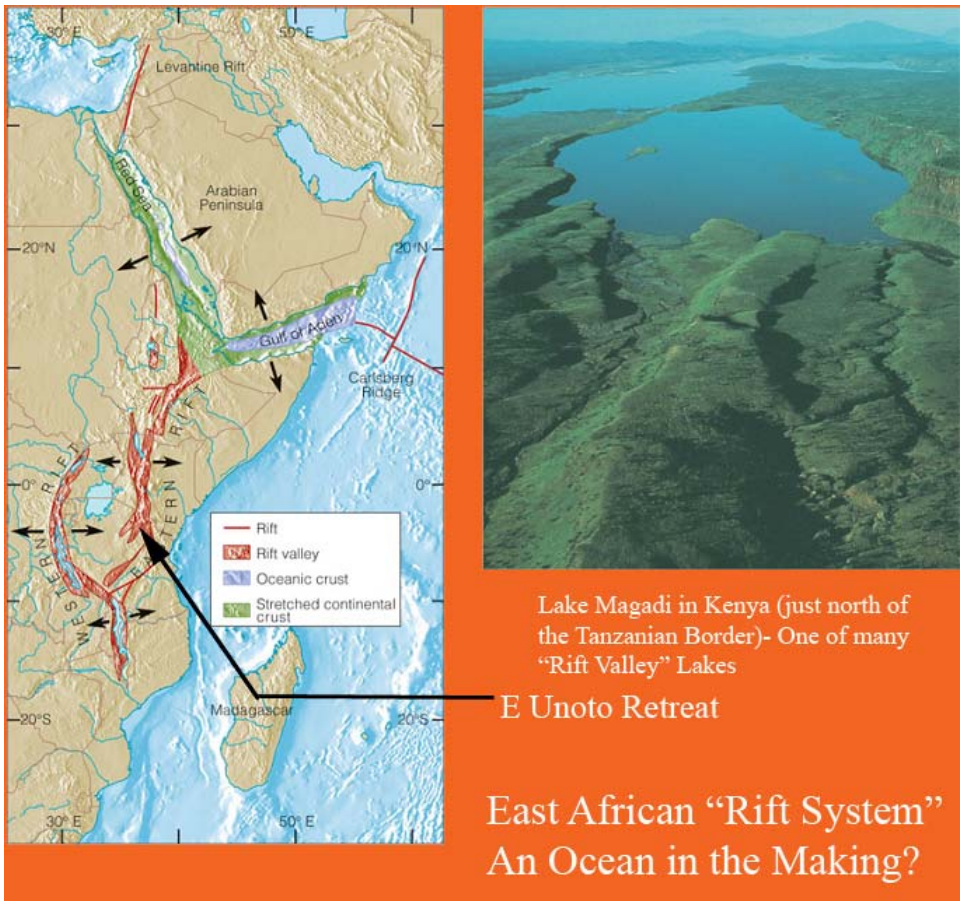

Figure 1

As shown in Figure 1, the East African Rift Valley system extends from the Middle East to southern Africa. E Unoto Lodge is located about 50 miles south of the Kenya/Tanzania border at the base of the escarpment of the Eastern Branch of the East African Rift System. The Red Sea and the Gulf of Aden are areas where the continental plates have already split and have formed an ocean. The island of Madagascar has also split from the continent of Africa (along with India, which was connected to the east coast of Africa until about 140 million years ago). The rift system that stretches across the eastern part of the African continent is less than 20 million years old. These rifts could either break further apart over millions of years as has happened to create the Atlantic and Indian oceans, or the rift separation could abort, as has happened in west Africa (in Nigeria). Although it is only conjecture, if the Eastern Rift further separates we could have an intervening ocean with E Unoto becoming an oceanfront resort!

Thermal plumes below the earth's crust rise from deep in the mantle and create the tensional forces that eventually split the plates. As a consequence, the sites of potential continental break-ups contain volcanoes (which bring hot molten material- *the magma*- from deep inside the earth to the surface). As you look around E Unoto, you are surrounded by conical volcanoes with craters at their tops or collapsed volcanoes (after they emptied their molten material- *the lava*- onto the surface). The collapsed volcanoes are the *calderas*, such as the Ngorongoro (Figure 2).

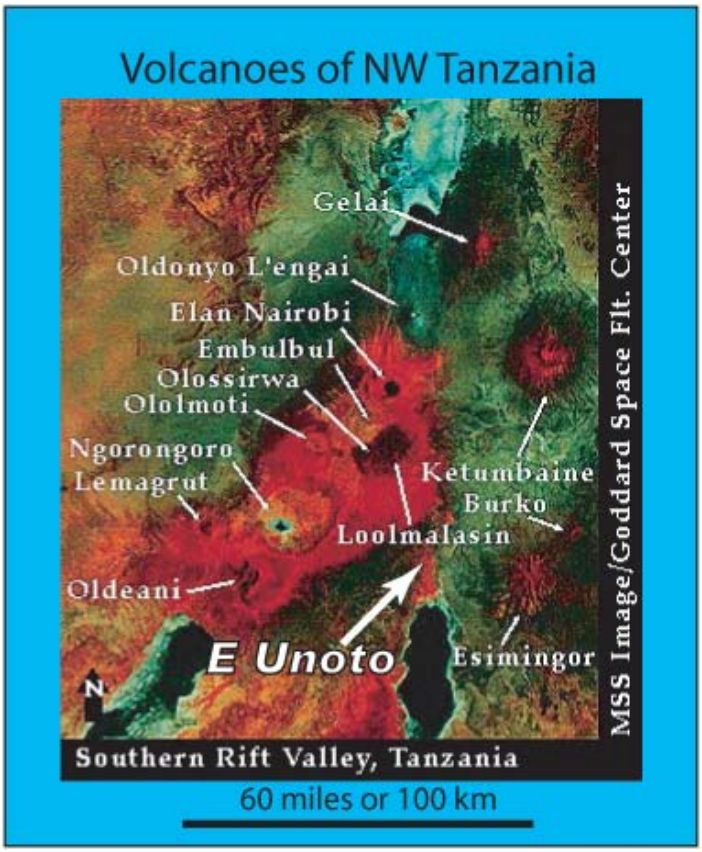

Figure 2

Not all the lava comes out on to the surface through the conical volcanoes. Lavas known as *flood basalts,* also leak out along cracks in the crust. These lavas form the vertical cliffs that you see behind the E Unoto Retreat. Figure 2 also shows Lake Manyara (just south of E Unoto), Lake Eyasi (in the southwest corner of the map) and Lake Natron (at the northern edge of the map). The lakes are bounded by *faults* (natural breaks in the earth along which vertical or lateral movements might take place). These lakes occupy relatively shallow basins where the faults have moved sideways to create a downdropped area. Waters that seep from the faults are rich in mineral content. As these waters find their way into the lakes and as lake beds face long summer months of evaporation with little fresh water coming in, they become rich in alkaline matter, hence the name *soda lakes*. This salt content is especially attractive to certain animals and birds, especially the flamingoes.

Underground water that comes in contact with magma chambers in the subsurface sometimes emerges at surface as thermal springs. There are a multitude of thermal springs in the area (Figure 3). Locations marked 1 through 6 are sites of known thermal springs. Notice the locations of Lake Manyara, Lake Eyasi and Lake Natron for orientation. The dark black lines on the map are faults that are part of the East African Rift System (also shown in red in Figure 1).

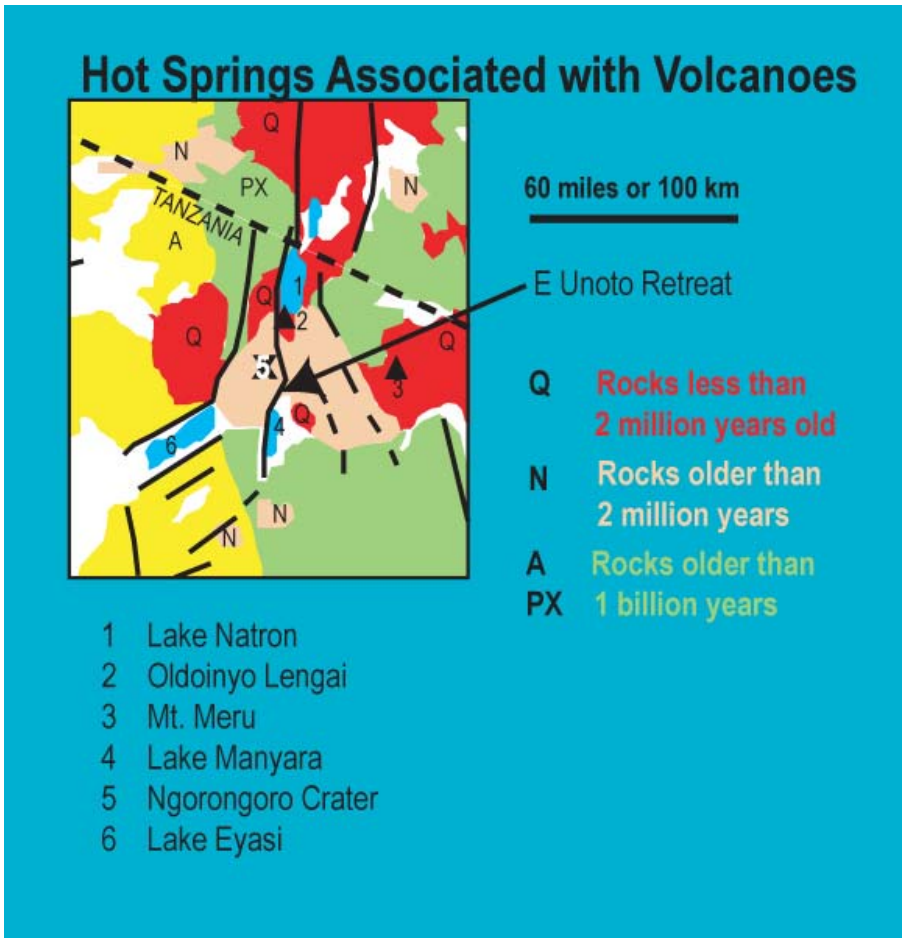

Figure 3

Figure 3 also shows the ages of rocks in the vicinity of E Unoto Retreat. Yellow and Green areas displays rocks older than 1,000 million years (west of E Unoto) and to the south of Lake Manyara. The remainder of rocks are either between 20 and 2 million years (marked N, in light beige) or less than 2 million years (marked with Q, in red). White areas are those where the nature of the bedrock is unknown. Most of the volcanic activity in the area is very young. Volcanism began approximately 5 million years ago. Major fault escarpments were formed by 3 million years ago and the escarpment behind E Unoto Retreat is probably younger than 1.2 million years old.

Hike up the escarpment behind the retreat - An exhilarating, but quite challenging, 4-hr hike awaits you immediately behind the lodge. You will have an overview of the majesty of the volcanic hills and Lake Manyara in the distance and the plains of the rift valley (Figures 4 and 5). You climb almost 500 meters (1,500 feet) vertically within one kilometer horizontally (0.6 miles). On the way you will see a variety of volcanic rocks. Rocks you would encounter are called basalts, olivine basalts when they have a significant amount of this green mineral (Figure 6), and andesites (Figure 7). Some of the rocks have large crystals, others have small crystals. Some of the rocks have well developed larger crystals in a matrix of fine-grained material. Such texture in igneous rocks is referred to as *porphyritic*.

Figure 4: The slope reaches 25 to 30 degrees in places but there is a village at the top.

Figure 5: Enjoy the view from the top. Lake Manyara is in the distance.

Figure 6: Basalt, greenish mineral is Olivine

Figure 7: Andesite

Hike to the waterfall **-** *A* much gentler 4-hr hike (about 6km or 4 miles round-trip) to the south of E Unoto, without much vertical up or down, takes you to the base of the escarpment. Along the way you will see large boulders of volcanic rocks that have come down the escarpment. At the base of the escarpment are volcanic ash beds (known as *tuffs*) as well as *volcanic breccia* (volcanic fragments and ash all mixed together). Ash being softer than the basalts that overlie them gets eroded faster and causes the overlying rocks to collapse. In a streambed this collapse leads to formation of rapids, cataracts and waterfalls. In time the waterfall will gradually cut back into the mountain as the erosion and subsequent collapse continues.

Figure 8: Ash beds in the background at the base of the escarpment. Giant boulders have fallen from the top as erosion progresses

Figure 9: Waterfall on the Mto Wa Simba creek. Basaltic rocks being more resistant to erosion allow the vertical waterfalls to form.

Although not in the immediate vicinity of E Unoto, the following two locations are also geologically unique. All visitors to Serengeti pass by Olduvai Gorge and all visitors to Lake Natron will see Oldoinyo Lengai (pronounced *Ol-do-inyo Lenkai*, Mountain of God) volcano**.**

The Olduvai Gorge – It is now widely accepted by paleontologists and anthropologists that humans originated and evolved in Africa before migrating around the world starting probably within the last 200,000 years. The paths of migrations of our ancestors out of Africa have been traced now with DNA evidence, along with more traditional fossil and anthropological evidence. Within the Ngorongoro Conservation Area, there is a short detour (5 km or 3 miles) from the main road on the way to Serengeti at Olduvai Gorge (pronounced *Oldupai).* It was here that some of the oldest fossils of direct and indirect human ancestors were discovered by Louis and Mary Leakey in 1959. Additional finds have been made since then. The museum at the site explains the history and origin of human species To document the history of human evolution, research at the site continues. It is humbling to think that ancestors of every one of us on the entire planet probably started from a site like this in Africa. For further information, please go to the following sites:
http://www.pbs.org/wgbh/aso/databank/entries/do59le.html

http://www.indiana.edu/%7Eorigins/

The Oldoinyo Lengai (Mountain of God) – Just south of Lake Natron, you will see this 2,890 m (9,470 feet) volcano with white material on top. It is not snow. It is the only volcano in the *entire world* that extrudes natrocarbonatite (volcanic material containing a large proportion of carbonates- such as calcium and sodium carbonates- chemicals commonly occurring as chalk and baking soda, respectively). The natrocarbonatite at this volcano is made up of largely two minerals, nyerereite (named after Julius Nyerere, the first president of independent Tanzania and who is referred to as the "father of the nation") and gregoryite (named after J.W. Gregory, mentioned earlier). The volcano is active. Eruptions occurred as recently as in 2006. Lavas from this volcano are black initially, but turn white in a few weeks. These lavas are *anhydrous* (i.e. they contain no water) initially, but when they come into contact with the moisture of the atmosphere, they react extremely quickly. A six-hour climb takes people to the top of the mountain – obviously it is not for everyone. For more information on Oldoinyo Lengai, please go to:

http://www.v-e-i.de/english/volcanoes/oldoinyo_lengai.html

Figure 10

Finally, consider carrying home a geological souvenir. A blue-violet gem, called Tanzanite is found at one location in Tanzania in the entire world. It was discovered only in 1967. For more information, please go to the following site:
http://www.gemstone.org/gem-by-gem/english/tanzanite.html

Naresh Kumar, Ph.D.
Dallas, Texas (June, 2006)