Scientists' high hopes for explaining high elevation of Southern Africa

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(PhysOrg.com) -- Scientists at the University of Glasgow are embarking on a project to try to establish how and when southern Africa obtained its unusually high elevation - which might also explain a key event in human evolution.

The southern and south-eastern parts of Africa are almost entirely above 2,000ft in altitude but, unlike mountain ranges where height results from the squeezing and thickening of the earth's crusts at the point where two tectonic plates converge, South Africa is not near a plate boundary.

Currently there are several different models which seek to explain how and when the land acquired its height - the most contentious being the theory that it came into being relatively recently in earth's history - less than 30 million years ago.

Recent studies of the deep mantle have identified a region beneath southern Africa where a plume of hot, upward flowing mantle - rocks which are hotter, therefore softer, than the surrounding material - which originates close to the Earth's core.

Professor Roderick Brown of Geographichal and Earth Sciences, who is leading the project which has received £382,549 from the Natural Environment Research Council, said: "Some scientists now believe that it is this active flow that is literally pushing the Earth's surface upwards from below and is the cause of the unusually high elevation of southern Africa.

“This raised elevation may also have played a significant part in the evolution of early man - some research has suggested that the shift in elevation altered the climate and resulting in a migration northwards towards Europe as aridification changed rainforests into savannah grasslands1.”

In conjunction with Dr Cristina Persano and Dr Fin Stuart, senior lecturer in isotope geoscience, at the Scottish Universities Environmental Research Centre, East Kilbride, Prof Brown will examine a specific type of mineral found within rock which he hopes will establish a rough timeline of the elevation.

He said: “Precise measurements of surface uplift cannot be measured because there is no direct evidence which allows us to reconstruct changes in elevation in the past.

“However, uplift of the surface would have caused an acceleration of erosion, especially around the edges of the uplifted region and there are a number of techniques which can be employed which reveal the history of erosion.

“These techniques provide a record of the temperatures that a rock experienced in the ancient geological past, over millions of years. This is relevant because when the Earth's surface erodes, rocks cool as they are brought up from deeper, hotter levels.”

The team will employ two techniques - both measuring the decay of Uranium238 particles within the mineral apatite.

The first will look at the fission decay of U238 when the nucleus splits into two roughly equal parts which are repelled from each other leaving tiny tracks. Because U238 decays at a known rate, by counting the tracks and measuring their lengths the researchers can reconstruct the thermal history of a rock, because the tracks lengths are very sensitive to temperatures of 60-110 degrees Celsius - typical of the shallow crust.

The second method will examine the results of alpha decay where helium nuclei are ejected from the U238 atoms. By measuring the amount of helium gas that has accumulated within a grain of apatite, the team can determine how a rock has cooled from temperatures of 70-40 degrees Celsius to its present temperature.

Prof Brown said: “Combining these techniques provides a powerful tool for measuring the deep erosion of continental topography over geological time scales.”

The scientists will take rock samples from different depths from a bore hole drilled in the 1970s when the South African government was prospecting for oil.

Once they have established the rocks’ past temperatures and relate it to the depth at which those temperatures occurred in the crust, they can accurately determine when, and how much of, the land surface has eroded and hence resolve when the topography was created.

Prof Brown added: “I expect to discover that the elevation has occurred fairly recently in time and it might very well tally with the dates of when humans started migrating out of Africa.

“This migration might have been aided by the raised land altering wind patterns resulting in aridification which changed rainforest to savannah grassland, opening up new, fertile lands to humans which they could easily travel through which supplied ample amounts of food and water.

“Hopefully this project will resolve a critical sticking point in understanding how continental topography evolves.”

More information: 'Tectonic Uplift and Eastern African Aridification', Sepulchre et al, Science, 8 September 2006
www.sciencemag.org/cgi/content … stract/313/5792/1419

Provided by University of Glasgow