Geophysical Research Abstracts
Vol. 12, EGU2010-2378-2, 2010
EGU General Assembly 2010

A high resolution and continuous isotopic speleothem record of paleoclimate and paleoenvironment from 90-53 ka from the south coast of South Africa

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The south coast of Africa is near the confluence of two oceans (Atlantic and Indian) and two major oceanic systems influential to world climate - the cold Benguela Upwelling on the west coast and the warm Agulhas Current flowing down the east coast.
The south coast is also at the juncture of a winter rainfall system to the west and summer to the east, and the relative positions of these systems in reaction to global climate change have long been a focus of study and debate. Coastal South Africa draws interdisciplinary interests due to the co-occurrence of a rich record for early human behavioral modernity, hyper-diverse vegetation with very high endemism (the Cape Floral Region, CFR), and globally influential oceanic and climate systems. There is also a transition from C3 grass domination in the winter rainfall areas to the west to more C4 grass representation to the east in the summer rainfall areas. High resolution and continuous climate and environmental records are needed to provide the context for the evolution of behavioral modernity and this diverse flora. The coastal cliffs are highly folded and faulted exposures of the Skurweberg Formation of the Paleozoic Table Mountain Sandstone Group (TMS). This formation comprises coarse-grained quartzitic sandstone. Shear zones with boudinage features cut through the TMS, and large number of caves and rockshelters are found in these eroded fault breccias. The offshore platform was the source for much of the aeolian sands that comprise the extensive ancient dune systems on land and in the caves. Speleothems are present in almost all the caves, often intercalated with archaeological deposits, and almost always occurring behind aeolianite remnants. The intercalation of speleothem with sediments affords the opportunity to conduct both uranium-thorium dating (U-Th) and optically stimulated luminescence (OSL) on intercalated sediments.
Here we present the first high resolution and precisely dated record for climate and environmental change from 90,000 to 53,000 years ago on the south coast. This important time span covers a burst of expression of several indicators of human behavioral modernity, as well as several key cycles in global climate change. Our research location (Pinnacle Point near Mossel Bay) is ideally placed near the location of several critical archaeological sites, near the boundary of the winter and summer rainfall regimes, and close to isotopically distinct floral zones. The isotopic analysis (oxygen and carbon) of precisely dated speleothems document shifting vegetation and rainfall, and show that the presence of winter rain and C3 grasses waxes and wanes in response to Southern Hemisphere shifts in sea surface temperatures and global temperature. When proxies of global temperatures indicate warmer conditions, oxygen and carbon isotopes indicate of the speleothems undicate more winter rain and more C3 grasses, and vice versa. This record displays abrupt and short-term changes previously undocumented. It is often argued that the Cape Floral Region partially owes its high diversity to relative climatic stability. Our record shows isotopic variability that at least matches the variability displayed in the Levantine Mediterranean system,

so climatic stability may not have characterized the south coast. One short-lived phase of human technological innovation (the Still Bay) associated with early evidence for behavioral modernity occurs synchronous with an abrupt environmental perturbation. Early modern humans in this region confronted a variable climate and adapted quickly in a manner similar to behaviorally modern humans.