The Formation of the Richat Structure

Figure 1 – An aerial photograph of the Richat Structure.

Introduction

The Richat Structure or the "Eye of the Sahara" is somewhat of an enigma to geologists today. It is 40km in diameter, and represents 3 major rings dipping outward from the centre of the structure. This circular feature representsan eroded geologic dome, with sedimentary rocks of late Proterozoic and Ordovician Age.

The Problem

The origin of theRichat Structure and the underlying magmatic body is not fully understood, and this project main objective is to solve this. Originally it was thought to be a meteorite impact structure, however studies undertaken by *Robert S Dietz et al 1968*confirm that there aren't any features that would commonly be associated with "shock processes", and therefore this cannot be an impact structure.

Previously the mineral Barite was misinterpreted for Coesite, a mineral that is indicative of shock metamorphism from high velocity extraterrestrial impacts. It probably represented a shear zone that developed in tectonic doming rather than a meteorite impact (R.F.Fudali 1969).

General Lithologies

The centre of the Richat Structure is comprised of a limestone-dolomite shelf that encircles a large scale Breccia that was formed by Karstdissolution and collapse. Due to the presence of neo-formed Cretaceous K-Feldspar it has been interpreted that these sediments have a hydrothermal origin of Cretaceous age. Basaltic ring dykes, Kimberlites, and alkaline volcanic rocks intrude and post-date these internal sediments further suggesting that there was an alkaline magmatic body beneath the Richat Structure *(Matton et al 2005).*

Current Hypothesis

The origin of the RichatStrucure has been hypothesised as an eroded anticlinal dome, however its formation is not entirely understood. It is also thought that there is an underlying large alkaline magmatic body, and this project will hopefully prove or disprove this.

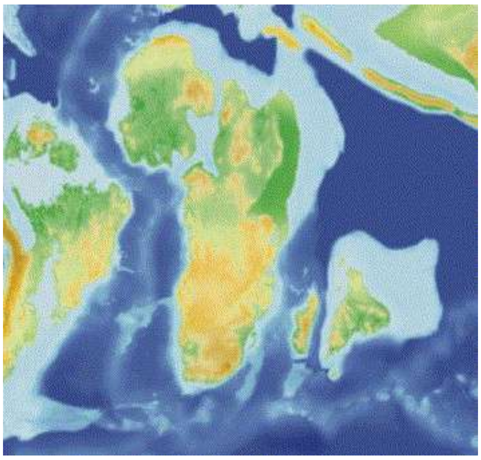

Figure 2 – A continental reconstruction from the late Cretaceous *(Doucoure and de Wit 2003)*

The injection of an alkaline magma occurred during the Cretaceous period *(Matton et al 2005)*, at this time the position of the North Western African continent was near to the Southern Atlantic Ocean during the oceans embryonic stages of spreading (Figure 2). This is a rather peculiar location to find an alkaline magma, because alkali magmas are usually associated with continental rift systems such as in East Africa, however there isn't a rift system in close proximity to the Richat Structure. The Injection of this alkaline magma may have occurred due to the extension and thinning of the crust near Mauritania.. It has been hypothesised that the magmatism may be attributed to a mantle plume, heating the base of this thinned crust *(Collins 2011)*These two factors combined together are the most likely cause of continental alkali magmatism. The opening of the Atlantic has been attributed to plume activity and lead to the formation of the Peri-Atlantic Alkaline Province where the Richat Structure is located *(Matton 2008)*. The presence of Kimberlites is not surprising, due to the fact that some of the oldest crust in the world is located in the western African Craton, a typical tectonic setting for Kimberlites. Finally it may have been the upwelling of this magma that caused up warping and doming of the overlying sediments. This can be inferred because there is not any kind of convergent plate boundary in close proximity to produce fold tectonically.

This Project and Methodology

Figure 3 – A photograph showing the proposed drilling site. *(Google Earth Copyright 2013)*

The proposed drilling site for thisproject is at the centre of the structure (as seen above in Figure 3) at the approximate GPS co-ordinates of 21°07'30" N, 11°24'00" W.This project plans to drill a borehole approximately 20km into the structure to penetrate into the magmatic body below*(Matton 2008)*. Enabling us to identify exactly what the source of the ring dykes are by geochemical analysis, such as the LREE, HREE, LILE, and incompatible elemental compositions of the magmatic body. This may also unearth data that has not previously been seen, such as the subsurface lithologies. It will either confirm or disprove the presence of a subsurface intrusion and identify its source. Furthermore, we can compare the composition of the alkali magma with that of other magmas

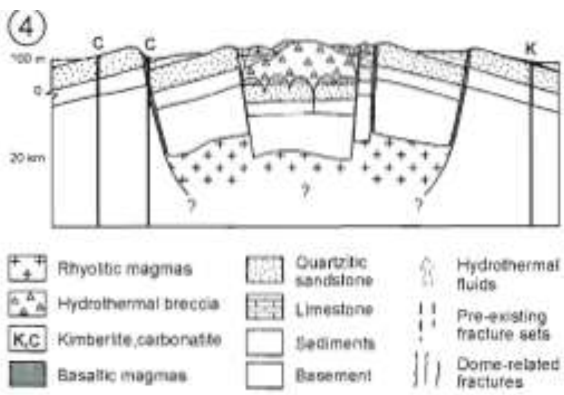

Figure 4 – Cross Section of the Richat Structure *(Matton) 2008)*

that have identified sources. This data can then be correlated with the rocks brought up from within the borehole.Elemental similarities between these samples and other igneous rocks with known sources can be identified and interpreted.

If the rocks have a chemical signature that is enriched in incompatible elements, then we can confirm that it has a deeper mantle source, similar to that of OIB.

Geophysical Data
Shallow and deep seismic profiling will have to be carried out here. Both of these datasets will becorrelated with borehole lithological data to work out an accurate cross section. This will enable us to have a deeper understanding of the subsurface geology, and ultimately it will allow us to understand the processes of its formation. If possible three dimensional profiling of the crust here would be perfect because it would give us a further insight into the details of structures below the Richat Structure. A Magnetic survey could be carried out, which would be useful because the minerals within the igneous rocks would have a higher magnetic signal than that of the country rock. Therefore this would give us some indication of where to drill. A gravity survey will also be carried out, due to the fact that the intruded igneous rocks would have a higher specific gravity than the country rock, therefore giving more detail about the location of the magmatic body.

Problems

- A Possible problem with the project is that the magmatic body may not be directly below the centre of structure itself, and so drilling may not enable us to locate the source of the igneous lithologies.Doing the initialgeophysical survey and then drilling would solve this.
- Conditions in the Sahara may provide some issues, mainly the temperature would be an issue, where in the summer the temperature regularly exceeds 50°C. This could lead to dehydration of the research scientists, however very simply always carry sufficient water, or just carrying out the research in the winter months could solve this.

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