Seaward-Dipping Reflector Formation by Multiple Magma Chamber Inflation and Collapse Cycles and Implications for Hydrocarbon Exploration

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ABSTRACT

Many differing models have been proposed for the formation of volcanic seaward-dipping reflectors (SDR) based mainly on either seismic reflection interpretations or field studies. This presentation attempts to reconcile these two lines of evidence and explain the observed rapid subsidence of subaerial volcanic lavas which can produce the characteristic convex-up shape of the bedding. The proposed model involves multiple inflation and vertical collapse of lensoid magma chambers developed during crustal extension, but without major faulting. The preferential removal of magma from the centre of the chamber causes a curved collapse of the chamber roof; and magma is taken to surface by important sub-vertical diking. Dikes can transfer large volumes of magma to the surface, and their importance to the formation of SDR may have been underestimated. This is because the dikes are usually less than 10 m thick and therefore invisible on most seismic data. Magma chambers can inflate and collapse many times at the same location to produce a large cumulative subsidence of the lavas. Many localised angular unconformities with shallower dipping lavas overlying steeper-dipping sequences can be observed on seismic data in outcrop; these can only be explained by these inflation/collapse cycles. The collapse is much more rapid than tectonic subsidence observed in most rift settings, with 8-10 km of subsidence in < 2.9 Ma. Weakening of the crust by dyking would allow very rapid extension and subsidence. Because most of the extended accommodation space is filled with SDRs there is little evidence of extensional half graben development. Field evidence and well bores from the N and S Atlantic margins indicate that the SDR sequence is mainly composed of volcanics with some thin intercalations of continental clastics at the landward edge. Hence, the source rock potential within the small rifts or within the SDR sequence is very limited; and the hydrocarbon potential of volcanic margins will be dependent on the presence of post-rift source rocks.