



NUMERICAL MODELLING OF MUD VOLCANOES AND THEIR FLOWS USING CONSTRAINTS FROM THE GULF OF CADIZ

Bramley J. Murton (1), Juliet Biggs (2)

(1) Southampton Oceanography Centre, UK, (2) Dept. Earth Sciences, University of Cambridge, (bjm@soc.soton.ac.uk)

It is estimated that the total number of submarine mud volcanoes is between 1000 and 100,000. Because many are associated with greenhouse gasses, such as methane, it is argued that the global flux of these gasses to the atmosphere from the world's terrestrial and submarine mud volcanoes is highly significant. Clues to the processes forming submarine mud volcanoes can be found in variations to their height, shape, surface morphology, physical properties and internal structure.

A model of isostatic compensation between the mud column and the sediment overlying the mud source is used to predict a depth to the mud reservoir beneath mud volcanoes. Once erupted, the general behaviour of an individual mud flow can be described and predicted using a viscous gravity-current model. The model shows that conical-shaped mud volcanoes comprise multiple, superimposed radial flows in which the thickness, eruption rate and speed of individual mud flows strongly depends on the viscosity, density and over pressure of the erupted mud. Using these parameters, the model predicts the lowermost flows will be the oldest, thickest and have the greatest length of run-out while the uppermost flows will be the youngest and thinnest and shortest. This model is in contrast to more traditional models of stratiform mud volcano construction in which younger flows progressively bury older ones and travel furthest from the summit.

Applying the model to the two mud volcanoes studied in the Gulf of Cadiz, quantitative estimates are derived for the depths to mud sources, exit and flow velocities, eruption duration and volume fluxes, flow thickness and conduit radii. For example, with an average kinematic viscosity of $1.5 \text{ m}^2\text{s}^{-1}$ for the erupted mud, a density of $1.8 \times 10^3 \text{ kgm}^{-3}$ and a thickness for the youngest flows of about 0.5 m, the model

predicts a lowermost flow thickness of 3.6 m, an average eruption duration of 7 hours and a conduit radius of about 9 m. To construct a conical-shaped mud volcano of 260 m height, similar to those studied in the Gulf of Cadiz, is estimated to require a mud source at 4.6 km depth and a total of at least 100 individually erupted flows.