Supplementary Information for

Hydrothermal activity at a Cretaceous seamount, Canary Archipelago, caused by rejuvenated volcanism

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This supplementary text contains background information on the heat flow modelling and the shipborne methods.

1 Heat Flow Modelling

For all modelling we used the Partial Differential Equation (PDE) Toolbox based on Matlab®.

To assess the influence of sediment thinning close to the seamount, we set up a steady-state conductive finite element model with axial symmetry and the seamount center as midpoint. Sediment thickness was picked from the seismic profile (**Fig. 4a**) from the base of the seamount to about 4 km southwest of it; farther afield the sediment thickness was set to 500 m. The conversion from TWT to meters used a constant p-wave velocity (v_p) of 1600 ms^{-1} as no velocity vs. depth information was available from the seismic data set. We used a constant thermal conductivity of 1 $WK^{-1}m^{-1}$ for the sediment and 2.5 $WK^{-1}m^{-1}$ for the basement and intrusive bodies. The heat flow into the model at the base of the lithosphere (basal heat flow; q_{bas}) was iteratively adjusted to minimize the misfit between measured and predicted heat flow between traverse distance 0 and 20 km, yielding q_{bas} = 48 mW m^{-2}. Variation of sediment v_p between 1550 m/s and 1650 m/s, or of the thermal conductivity contrast between sediments and crust from 1:2.5 to 1:2, changes calculated heat flows by no more than 1 mW m^{-2}.

To simulate conductive cooling of an intrusion as possible cause for the observed heat flow increase near Henry Seamount, we set up an axial-symmetrical model with the same geometry and thermal conductivities as the steady-state conductive model, above. As an extreme case, we assumed a vertical cylindrical intrusive body with a diameter of 100 m, extending all the way to the top of the seamount, and infinite downward extension. The intrusion is emplaced instantaneously at the seamount center (at the 30 km mark in the transect; **Fig. 4**). It has an initial temperature of 1200 °C and cools as the heat diffuses radially; the latent heat of crystallization is neglected. We assumed densities of 1500 and 3300 kg m^{-3} for sediments and igneous basement, respectively, and a specific heat of 1170 $JK^{-1}kg^{-1}$ for both.

2 TV Sled Surveys and Multibeam Data Acquisition

For TV-sled surveys the instrument was towed about 2 m above the seafloor at a speed of 0.2-0.4 knots. Two miniature autonomous plume recorders (MAPR) built by Pacific Marine Environmental Laboratory were attached to the sled and 10 m above it. Each MAPR contains a pressure gauge to record the water depth, a thermistor with a resolution of 0.001 °C, a nephelometer that senses scattered light from a small volume within centimeters of the sensor window, and an oxidation-reduction potential (ORP) sensor that responds to reduced hydrothermal chemicals in the water column (Baker et al., 2016).

Bathymetric surveys used the METEOR's hull-mounted Kongsberg EM122 multibeam echosounder system. The nominal sonar frequency is 12 kHz with an angular coverage sector of up to 150° and 288 beams per ping across-track; the acustical footprint is 1° along track and 2° across track. The swath width was set to 120° (60° port and starboard). Local high-resolution bathymetric and backscatter data were obtained using the AUV MARUM SEAL 5000 and its Kongsberg EM2040 system, which was operated at 400 kHz for the first dive and at 300 kHz for subsequent dives.

3 Heat Flow Determinations

Heat flow determinations used the 6 m long Bremen heat flow probe operated in a pogo-style mode. It is constructed in the classical "violin bow" design (Hyndman et al., 1979; Villinger et al., 2010), with 21 thermistors distributed over an active length of 5.2 m and mounted in 0.26 m intervals inside an oil-filled hydraulic tube. The sensor tube also contains a heater wire for the generation of heat pulses for in-situ thermal conductivity measurements. The signal of the temperature sensors was measured at a sample rate of 1 Hz and a final temperature resolution of better than 0.001 K at ambient seafloor temperatures. A calibrated PT-100 seawater sensor on top of the weight stand allowed measurement of the absolute bottom water temperature and provided a check of the calibration of the sensor string in deep water with high accuracy. Inclination and acceleration of the probe were measured to monitor the penetration into the sediments and potential disturbances during the actual measurement period. Because the penetration generated a thermal disturbance due to frictional heating, and the sensor string had to come into thermal equilibrium with the sediment, the decay was recorded over a time interval of 7 to 8 minutes. The final temperature was derived by a theoretical decay model (Villinger and Davis, 1987). In-situ thermal conductivity was determined by applying a heat pulse on the order of 800 J/m on the sensor string for 20 seconds and measuring the temperature decay for 8 minutes (Lister, 1970). A POSIDONIA pinger mounted to the coring wire 50 meters above the instrument allowed us to monitor the exact position of the heat probe on the ocean floor.

4 Reflection Seismics

Seismic data were collected with a high-resolution seismic system consisting of a digital Geometrics GeoEel solid streamer and an Applied Acoustics DeltaSpark sparker array source. The sparker was supplied with six single tipped electrodes and operated at 6000 Joules. It was connected to a Capacitor Charging Unit (Model CPS-S 6000) that was fully charged after ~9 s. The shooting rate was 9.5 s resulting in a shot point distance of ~20 m at 4 knots surveying speed. The sparker was stabilized by two elongated buoys and towed at ~1.1 m depth, ca. 15 m behind the vessel. The streamer system consisted of a tow cable (80 m, 40 m in water), one 10 m long vibration isolation section, 9-10 active sections of 12.5 m each, a vibration isolation section at the end of the streamer, and an end buoy. An active section contained eight channels (spacing of 1.56 m), resulting in 72-80 channels within the streamer. The processing included a band pass filter, a fk-filter, despiking, CMP-binning, Super gather generation, a static correction, a Normal-Move-Out correction and a finite differences time migration.

5 References Cited in the Supplementary Text

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