SPOTLIGHT 2 | Jasper Seamount

30°26.40'N, 122°44.40'W

By Jasper G. Konter, Hubert Staudigel, and Jeffrey Gee

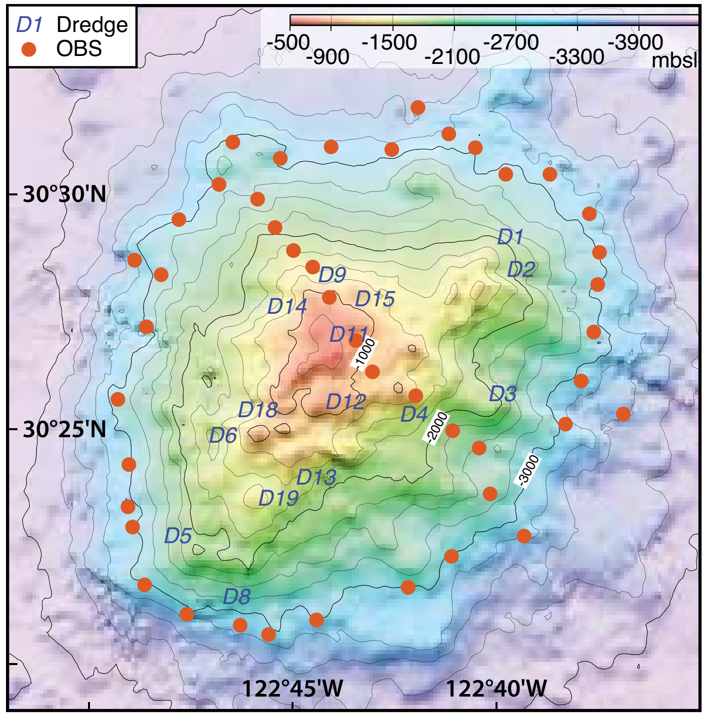

Figure 1. Gridded multibeam bathymetry map of Jasper Seamount (adapted from Konter et al., 2009). The seamount shows a slight northeast–southwest elongated summit and several small cones near the summit. Dredge hauls covered most of the seamount, and ocean bottom seismometers (OBSs) were located around and across the seamount during the seismic experiment. Gravity and magnetics tows were performed in multiple passes (not shown).

Jasper Seamount is a submarine volcano in the Fieberling-Guadalupe seamount trail, located off the coast of Baja California, Mexico. It rises from the 4000-m-deep seafloor to a summit depth of 700 m (Figure 1). Detailed geophysical, geochemical, and geological studies there provide an in-depth geological understanding of a seamount that approaches our knowledge of subaerial volcanoes. Active-source seismic experiments at Jasper Seamount resulted in the first seismic velocity models of an intraplate seamount (Hammer et al., 1994). Marine gravity and magnetics surveys, combined with analyses of the physical properties, geochemistry, and geochronology of dredge samples, enabled scientists to develop a detailed model of its internal structure (Gee et al., 1988, 1991; Pringle et al., 1991).

The resulting model of Jasper Seamount displays many similarities to models of the formation of typical Hawaiian volcanoes, in particular, the stage-wise eruption of increasingly alkalic rocks (Figure 2). More than 90% of the volcano is made up of tholeiitic to alkalic transitional basalts, defining the flank transitional series (FTS) that erupted 11.5–10 million years ago. This volcanic foundation resembles the shield-building phase of a typical Hawaiian oceanic intraplate volcano. Subsequent lavas erupted at Jasper Seamount are increasingly alkalic and define two distinct stages: the flank alkalic series (FAS; 8.7–7.5 million years ago) followed by the summit alkalic series (SAS; 4.8–4.1 million years ago).

At Jasper Seamount, the eruption of volcanic rocks containing increasing fractions of alkalies at a given SiO_2 concentration is interpreted to result from a decreasing relative melt fraction throughout the mantle melting history that brackets these three different eruptive periods. Konter et al. (2009) observed that the distinct evolutionary stages of Jasper also carry characteristic mantle source signatures for Sr, Nd, Pb, and Hf isotopes that evolve in a way that resembles typical Hawaiian volcanoes (Figure 3). The seamount's foundation

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(or shield) has isotopic mantle characteristics that are typical for long-term enriched incompatible element concentrations (e.g., low $^{143}Nd/^{144}Nd$), and later stages appear to be more depleted (e.g., high $^{143}Nd/^{144}Nd$). Altogether, these similarities are likely to indicate that processes generating magmas at Jasper Seamount and Hawai`i are quite similar, even though Jasper is a much smaller volcano (690 km^3) compared to a Hawaiian volcano (~ 30,000 km^3). This size difference is significant because the most widely accepted model for the origin of oceanic intraplate volcanoes (OIV) is almost exclusively based on studies of Hawai`i, which is the largest OIV globally. Expanding the Hawaiian evolutionary model to a much smaller seamount offers a rationale for the use of this model for this much more common class of OIVs (see Wessel et al., 2010). It suggests that the melting processes that produce the largest OIVs are actually similar to the processes that form much smaller seamounts.

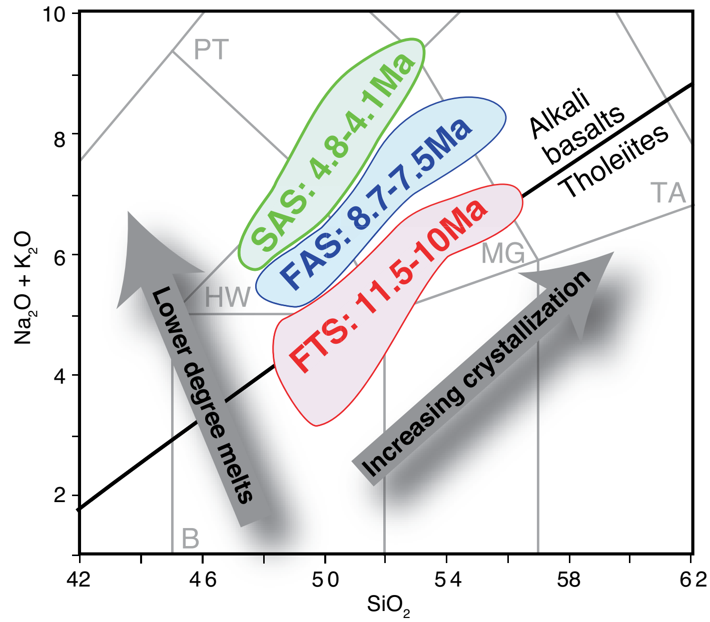

Figure 2. Major element composition of Jasper Seamount lavas showing that individual stages of the flank transitional series (FTS), flank alkalic series (FAS), and summit alkalic series (SAS) are distinct in composition and likely represent smaller degrees of melting with time. Within each stage, fractional crystallization creates a trend in the data. Key for fields with rock types: B = basalt. HW = hawaiite. MG = mugearite. TA = trachy-andesite. PT = phonolitic tephrite. *Adapted from Konter et al., 2009*

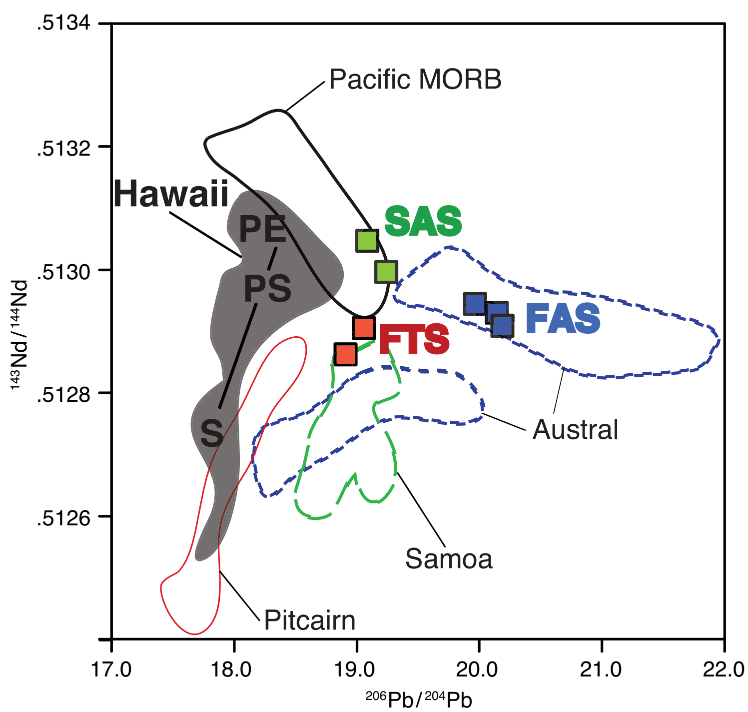

Figure 3. Pb-Nd isotope compositions of the flank transitional series (FTS), flank alkalic series (FAS), and summit alkalic series (SAS) are distinct and vary significantly compared to the range in oceanic basalts. In addition, the evolution in isotopic composition changes toward mid-ocean-ridge-basalt (MORB)-like compositions similar to the shield (S), post-shield (PS), and post-erosional (PE) stages in Hawai`i. *Adapted from Konter et al., 2009*

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