Why we need ultra-deep drilling into IBM arc crust?

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At first glance, intra-oceanic arcs do not appear to be the right place to study the production of andesitic magmas, because (1) modern magmatism at the intra-oceanic Izu-Bonin-Mariana (IBM) arc is bimodal, with basalt and rhyolite predominating (Tamura and Tatsumi, 2002); and (2) turbidites sampled during Ocean Drilling Program (ODP) Leg 126 in the Izu-Bonin arc, which range in age from 0.1 to 31 Ma, are similarly bimodal (Gill et al., 1994), suggesting that the bimodal volcanism has persisted throughout much of the arc's history. Moreover, such bimodal magmatism is not unique to the Izu-Bonin arc, with the 30-36.5 degrees S sector of the Kermadec arc, another example of an intra-oceanic arc, also exhibiting it (Smith et al., 2003; 2006; Wright et al., 2006). So why and how do we study the intra-oceanic arcs to solve the 'andesite problem'?

Closer inspection of the IBM arc remarkably reveals the presence of a significant volume of middle crust with seismic velocities of 6.0-6.8 km/s throughout the entire arc (Calvert et al., 2008; Kodaira et al., 2007a,b; Kodaira et al., 2008; Kodaira et al., 2010; Takahashi et al., 2007; Takahashi et al., 2008; Takahashi et al., 2009). This is remarkable because these velocities are characteristic of a wide range of intermediate-felsic plutonic/metamorphic rocks (Christensen and Mooney, 1995; Behn and Kelemen, 2003, Behn and Kelemen, 2006) and are similar to the mean velocity of andesitic continental crust, such material would not be expected to be present on the basis of the bimodal volcanism. Moreover, this crust is presently thickest beneath basaltic volcanoes and thinnest beneath rhyolitic volcanoes (Kodaira et al., 2007), which is another enigma.

One possible way to understand this phenomenon is to investigate arc crustal sections exposed on land in order to examine the relationship between volcanic and plutonic rocks and the generation of andesitic magmas, as exposed arc crustal sections typically include middle crust composed of diorite to tonalite to granodiorite (e.g. Kawate and Arima, 1998; Busby et al., 2006; DeBari and Greene, 2011). However, any continental crust we observe on the surface of the Earth will have experienced deformation, metamorphism, and been otherwise processed, perhaps several times from its creation in subduction zones to the present day, thus overprinting, resulting in the loss of, key information that can provide clues to its genesis.

'Ultra-Deep Drilling into Arc Crust' is the best way to sample unprocessed juvenile continental-type crust in order to observe the active processes that produce the nuclei of new continental crust, and to examine the nature of juvenile continental crust being generated at intra-oceanic arcs.