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New insights from IODP Expedition 340 offshore Montserrat: First drilling of large volcanic island landslides

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Montserrat now provides one of the most complete datasets for understanding the character and tempo of hazardous events at volcanic islands. Much of the erupted material ends up offshore, and this offshore record may be easier to date due to intervening hemiplegic sediments between event beds. The offshore dataset includes the first scientific drilling of volcanic island landslides during IODP Expedition 340, together with an unusually comprehensive set of shallow sediment cores and 2-D and 3-D seismic surveys. Most recently in 2013, Remotely Operated Vehicle (ROV) dives mapped and sampled the surface of the main landslide deposits. This contribution aims to provide an overview of key insights from ongoing work on IODP Expedition 340 Sites offshore Montserrat.Key objectives are to understand the composition (and hence source), emplacement mechanism (and hence tsunami generation) of major landslides, together with their frequency and timing relative to volcanic eruption cycles. The most recent major collapse event is Deposit 1, which involved $\sim$1.8 km cubed of material and produced a blocky deposit at $\sim$12-14ka. Deposit 1 appears to have involved not only the volcanic edifice, but also a substantial component of a fringing bioclastic shelf, and material locally incorporated from the underlying seafloor. This information allows us to test how first-order landslide morphology (e.g. blocky or elongate lobes) is related to first-order landslide composition. Preliminary analysis suggests that Deposit 1 occurred shortly before a second major landslide on the SW of the island (Deposit 5). It may have initiated English's Crater, but was not associated with a major change in magma composition. An associated turbidite-stack suggests it was emplaced in multiple stages, separated by at least a few hours and thus reducing the tsunami magnitude. The ROV dives show that mega-blocks in detail comprise smaller-scale breccias, which can travel significant distances without complete disintegration. Landslide Deposit 2 was emplaced at $\sim$130ka, and is more voluminous ($\sim$8.4km cubed). It had a much more profound influence on the magmatic system, as it was linked to a major explosive mafic eruption and formation of a new volcanic centre (South Soufriere Hills) on the island. Site U1395 confirms a hypothesis based on the site survey seismic data that Deposit 2 includes a substantial component of pre-existing seafloor sediment. However, surprisingly, this pre-existing seafloor sediment in the lower part of Deposit 2 at Site U1395 is completely undeformed and flat lying, suggesting that Site U1395 penetrated a flat lying block. Work to date material from the upper part of U1396, U1395 and U1394 will also be summarised. This work is establishing a chronostratigraphy of major events over the last 1 Ma, with particularly detailed constraints during the last $\sim$250ka. This is helping us to understand whether major landslides are related to cycles of volcanic eruptions.