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# Origin and significance of the 2011 El Hierro xeno-pumice

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During the first week of the 2011/2012 submarine eruption off El Hierro (Canary Islands), peculiar light-coloured pumiceous rocks (xeno-pumice) were found floating on the sea. The appearance of these rocks led to a potentially inappropriate response from the authorities, because the rocks were viewed as likely indicators of high-silica magma and possible explosive eruptive behaviour. However, the eruption remained a relatively minor and dominantly effusive event and the origin and significance of these peculiar xeno-pumice rocks for volcanic monitoring remains unresolved. Three contrasting models have been put forward, describing them as: a) recycled hydrothermally altered felsic magmatic rocks (*Meletlidis et al., 2012, Geophys. Res. Lett., 39:L17302*), b) sediment-contaminated high-silica magma (*Sigmarsson et al., 2013, Contrib. Mineral. Petrol., 165:601-622*) or c) frothy xenoliths from pre-island sedimentary strata that were melted while immersed in magma (*Troll et al., 2012, Solid Earth, 3:97–110*). Here, we combine the three available datasets to assess the origin of El Hierro xeno-pumice in the light of texture, mineralogy, major and trace element composition, and oxygen isotope characteristics in order to discuss their significance.

We note that: 1) Sedimentary relicts occur frequently in xeno-pumice samples with occasionally observed relict bedding. 2) Vesicle sizes are extremely variable, which documents multiple degassing events. The vesicles are biggest especially close to sedimentary relicts, likely the result of a complex mix of minerals and porewaters originally present. 3) The mineral assemblage of xeno-pumice includes quartz, smectite, illite, wollastonite, jasper and mica (XRD) and is akin to marine sedimentary rocks in the region (*Hoernle, 1998, J. Petrol.*,39:*859–880; Robertson & Stillman, 1979, J. Geol. Soc., 136*:47 $-$ $-$60; *Aparicio et al., 2006, Geol. Mag.* 143:181 $-$ $-$193). 4) CIPW norms calculated from xeno-pumice major element compositions show the samples to be Si-oversaturated, partly corundum-normative, but with not magmatic mineral components in the norm. 5) Trace element concentrations of xeno-pumice are unlike any magmatic rocks from El Hierro and La Palma, but similar to known sedimentary rocks from the region. 6) A distinct Eu anomaly, typical for continentally derived sediment, is present in xeno-pumice but absent in El Hierro and La Palma magmatic rocks. Lastly, 7) Oxygen isotope values range from 9.1 to 11.6 ‰ (n=6), which are elevated with respect to magmatic rocks from the Canaries (5.2 to $\sim$ 7 ‰), but are characteristic for sediment derived from a mixture of continental (S- and I-type) granite sources.

The combined datasets allow for a more thorough discussion on the origin of El Hierro xeno-pumice and we conclude that xeno-pumice is compositionally akin to sedimentary rocks from the region, but strikingly dissimilar to magmatic rocks from El Hierro and La Palma. We suggest a dominantly sedimentary origin for xeno-pumice. Xeno-pumice is therefore not an indicator for explosive felsic magma within volcanic plumbing systems, but a reflection of magma-crust interaction during ascent and emplacement. The occurrence of similar frothy sedimentary xenoliths in recent and historical eruptions on Lanzarote, Gran Canaria, Tenerife and La Palma make a case for xeno-pumice being a common phenomenon in the region.