Quaternary Newsletter
Report
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COMPILING A TEPHROSTRATIGRAPHIC RECORD OF HOLOCENE VOLCANIC ACTIVITY FOR THE VIRUNGA VOLCANIC PROVINCE, EAST AFRICAN RIFT

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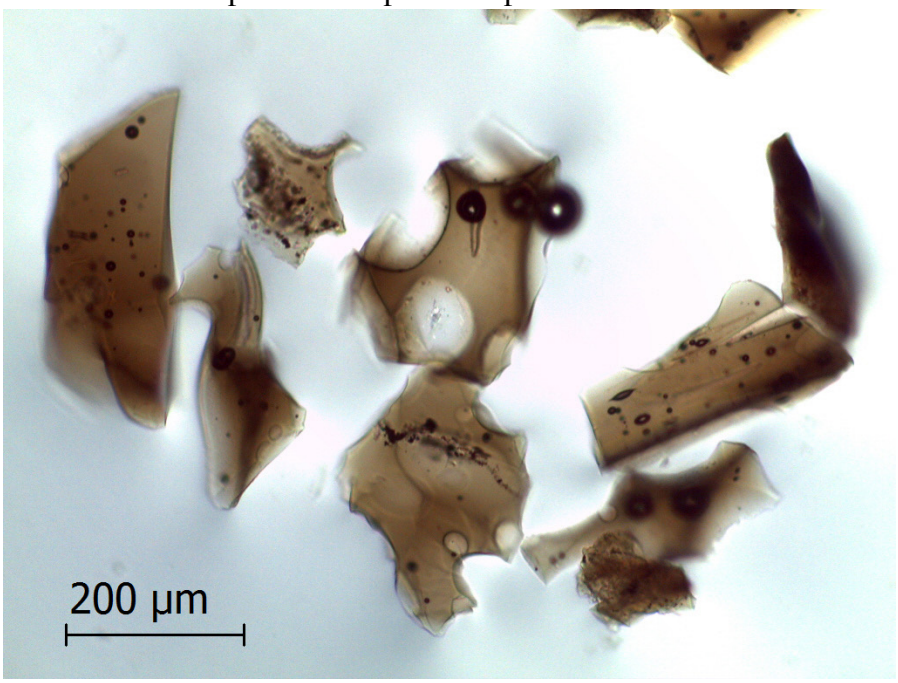
Lake sediments preserve invaluable stratified records of explosive volcanism, often with accompanying chronological controls or climatostratigraphic detail. In proximal areas where outcrop stratigraphies are complex, exposures isolated and sediments frequently eroded, the lacustrine archive provides a means to check the order of events and identify additional eruptions not preserved on land. Whilst lake sediment tephra research is commonplace in some regions of the world, few such records yet exist in central East Africa, where many population centres are located close to understudied, and potentially active, volcanoes. This is the case for the Virunga Volcanic Province (VVP), which lies to the north of Lake Kivu, where Uganda, Rwanda and the Democratic Republic of the Congo meet (Fig. 1). Between the Virunga ranges and Lake Kivu lie the cities of Goma (DRC) and Gisenyi (Rwanda), which together are home to more than 1 million people. Scoria cones from past eruptive activity surround these population centres (Poppe *et al*., 2016) and submarine volcanism is evident from seismic data (Ross *et al*., 2014). Of particular concern is the threat of a volcanically triggered lake overturn (Ross, 2014), which would be a catastrophic event for local populations. Supported with funding from the Quaternary Research Fund and Leverhulme Trust, a detailed geochemical study of tephra layers in Holocene sediment cores from Lake Kivu and pyroclastic outcrops sampled by Poppe et al. (2016) has been carried out, with the aim of building a first detailed tephrostratigraphy for the Virunga Volcanic Province.

Figure 1. Virunga Volcanic Province (VVP) and locations of cores, volcanoes and cities discussed in the text. Diamonds are short cores and circles are Holocene length cores.

Tephra layers in two Holocene-length cores (MANGO-KIVU-12C and MANGO-KIVU5A, see Zhang et al., 2014) were identified visually as distinct dark or light laminae, or as cryptotephra associated with magnetic susceptibility peaks. Further samples were collected from a suite of shorter Late Holocene cores in the Northern part of the Lake Kivu basin (Fig. 1), previously studied by Ross *et al*. (2014, 2015).

Where necessary glass shards were concentrated using standard cryptotephra extraction techniques described by Blockley et al. (2005). Glass shards from all samples were characterised using WDS-EPMA and LA-ICP-MS analyses.

The combined tephra record from lake sediment cores and associated outcrops indicates more than 20 explosive eruptions have taken place since ~12,000 years BP. Fig. 2 shows the typical appearance of the tephra glass shards from tephra layers within the MANGO-KIVU sediment records and a summary total-alkali-silica plot of all tephra compositions. The project has generated a substantial new dataset of tephra chemistries for the Virunga Volcanic Province, which typically erupts characteristic ultrabasic magma compositions. Not all tephra layers could be traced around the basin, or to a specific volcanic source, however a number of correlations were made between the sediment cores. Compositional groupings indicate that the record is dominated by tephra from eruptions of the Nyamulagira and Nyiragongo volcanoes, which is consistent with the outcrop record of scoria cone activity on the slopes of these edifices (Poppe *et al*., 2016).



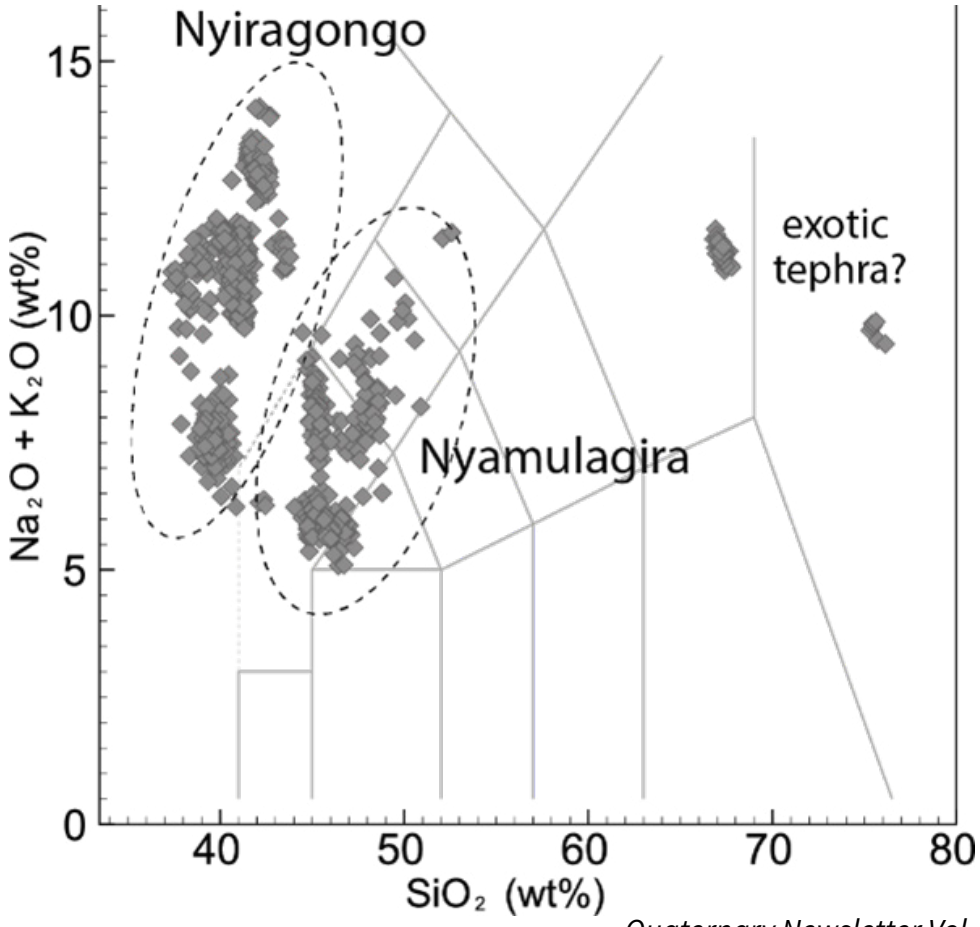


Figure 2. VVP tephra: (a) microscopic image of typical basaltic glass shards found in lake sediment cores; b) summary total alkali-silica plot of all tephra analysed from lake core and outcrop samples. Dashed envelopes indicate approximate geochemical ranges of Nyiragongo and Nyamulagira volcanoes.

Our results provide a first insight into the explosive eruption frequency of the VVP during the whole of the Holocene, as well as demonstrating that lake sediment tephra and cryptotephra techniques can provide significant insight into the recurrence rate and activity levels of some of East Africa's many understudied volcanoes.

References

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