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Investigation of a sand sample from Eritrea

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REPORT

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Title:
Investigation of a sand sample from Eritrea

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Summary:

In late April 2016 NGU was contacted by ROFI concerning a problem with abrasion of tents and equipment in Eritrea. A sample of sand collected on site in Eritrea was subsequently submitted to NGU for characterisation.

The current investigation shows that the submitted sample basically consists of well sorted and well rounded aeolian (i.e. wind deposited) fine sand, 0.1-0.3 mm in grain size, mixed with unsorted glassy and vesicular fragments of volcanic ash (cinder). The ash particles in the submitted sample are up to 20 mm.

The current study is descriptive. No conclusions as to whether the submitted sample can explain the damages incurred on the ROFI equipment in Eritrea are presented. It is, however, clear that the ash particles are both mobile, due to their vesicularity and high surface to weight ratio, and in many cases forms grains of sharp glassy fragments. Thus, it is possible for fairly large ash particles to get carried by the wind, and the sharp edged grains will be more erosive than rounded ones. The chemical and mineralogical composition of the aeolian sand and ash particles does not imply any other detrimental problems to either health or equipment.

Problems with abrasivity of volcanic ash in high wind are known from other volcanic terranes in the world (for instance Iceland) and can be referenced to further explore the problems experienced in Eritrea.

Keywords: Sand	Eritrea	

CONTENTS

1. INTRODUCTION

In late April 2016 NGU was contacted by ROFI concerning a problem with abrasion of tents and equipment in Eritrea. A sample of sand collected on site in Eritrea was subsequently submitted to NGU for characterisation. This sample was received at NGU on April 28th 2016.

Figure 1. Photo of the submitted material

The submitted material consists of ca. 70 g of what appear to be unsorted sand, ranging in grain size from fine to coarse sand; the largest grains being slightly less than 20 mm in diameter (Figure 1). The larger grains are red or brown in colour, they are clearly vesicular with glassy cavities and, where un-eroded, with sharp edges. These grains are obviously of volcanic origin and represent volcanic cinder clasts, and the cavities in the grains formed by escaping gasses during a semi-molten stage. These roughly 0.1-20 mm particles are therefore more correctly classified as volcanic ash.

The finer sand fraction is brownish to yellow in colour, and seems to consist, at least partly, of mineral grains

2. MICROSCOPIC INVESTIGATION

The finer sand fraction was investigated using an optical microscope to ascertain the grain morphology and size distribution. The fine fraction shows very limited grain size variation and consists dominantly of single mineral grains which cannot be produced by weathering of the ash particles that make up the larger grains in the sample. The grains mostly appear well rounded, and together with the sorted nature of the material, points to an aeolian (deposited and eroded by wind) origin of the finer sand fraction. This material therefore does not require a local origin (Figure 2).

Figure 2. Microphotos of the fine fraction in the submitted sample. The fine fraction consists predominantly of rounded mineral grains of a fairly restricted size variation; 0.1-0.3 mm (no scale bar). The larger grains are all ash particles of volcanic origin; some of these grains are marked by circles.

The mineral grains making up the fine fraction of the material is clearly of variable composition with many light-colored grains of, most likely, quartz and/or feldspars. The minerals do appear to be mainly silicates, with little evidence of more dense oxidic or sulphidic minerals. Darker minerals are more iron and magnesium rich silicate phases. Ash particles or cinder clasts tend to be larger, but in reality cover all grain sizes from 0.1 to 20 mm in the sample. These clasts are reddish brown, they are afanitic or glassy and do not form individual mineral grains of the size fraction investigated; mineral grains are present in the cinder clasts but they are of submicroscopic size.

3. INVESTIGATIONS BY SCANNING ELECTRON MICROSCOPE (SEM)

In order to investigate the composition of the sand particles and the cinder clasts, and to observe the grain surface of the cinder clasts, the sample was investigated by scanning electron microscopy. The instrument used is a LEO 1450VP analytical SEM operated at low vacuum.

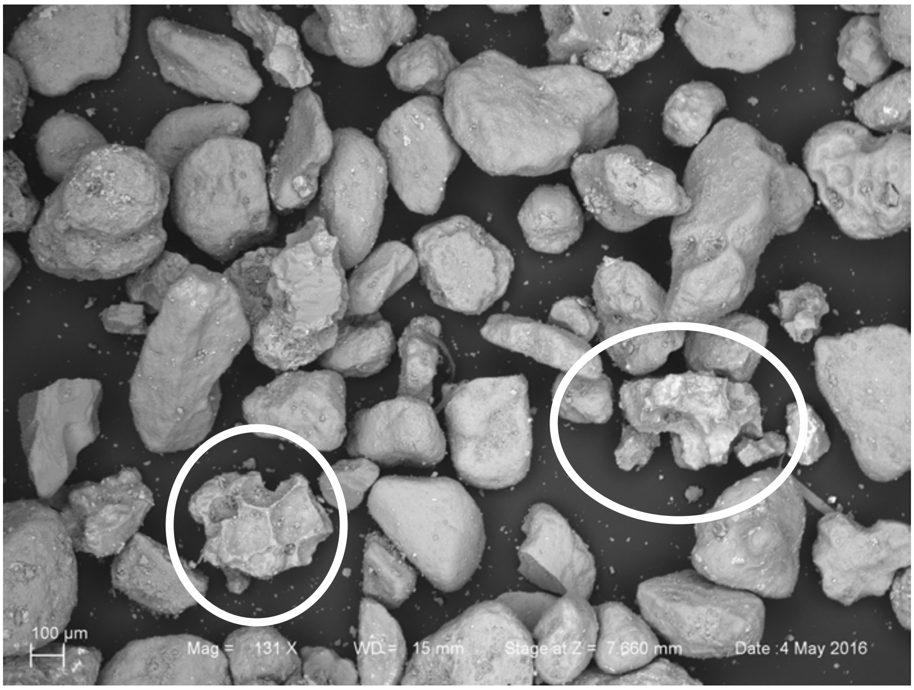

Figure 3. Backscattered electron image of the finer fraction of the sample. Two unrounded ash particles with sharp edges are marked by circles.

Figure 4. Backscattered electron image of the finer fraction of the sample. An unrounded ash particle is marked by a circle.

In backscattered SEM imaging it is also clear that there are two shape-types present (Figures 3 and 4). Most grains in the fine fraction are well rounded with a fairly uniform grain size of 0.1 to 0.3 mm. However, a significant number of grains in this size fraction is made up by volcanic ash with an irregular and vesicular appearance and sharp edges.

The rounded grains were semi-quantitatively analyzed with the SEM-EDS analytical system, but the nature of the sample makes the analytical resolution fairly poor. It is, however, clear that there are a number of minerals present in the fine fraction, including quartz, feldspars, ferro-magnesian silicates and calcite. A chlorine signal is almost ubiquitous and implies a presence of salt in the soil.

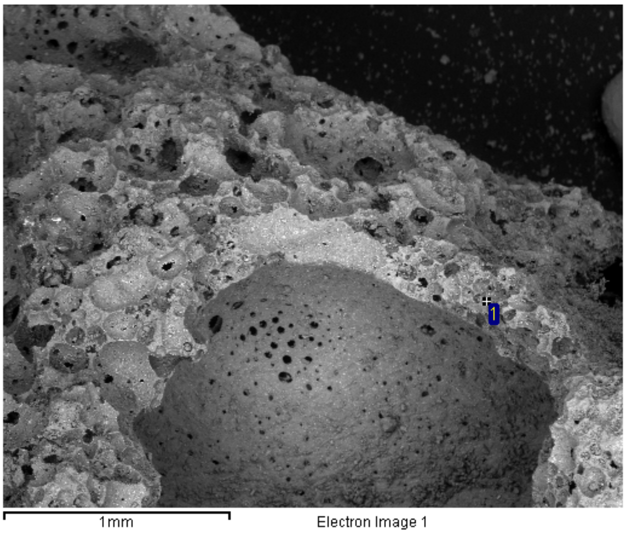

Figure 5. Backscattered electron image of a cinder clast with an analytical point marked by the number 1. Analyses yield compositions of ca. 50 % SiO_2, 15 % Al_2O_3, 10 % MgO, FeO and CaO. The composition roughly corresponds to a basaltic composition.

A number of analyses of the ash particles/cinder clasts yields somewhat variable composition but generally points to a basaltic composition of the volcanic material (i.e. around 50 % SiO_2). As seen in Figure 5 these volcanic cinder clasts are highly vesicular, sharp edged and glassy in morphology. It should be mentioned that even though the volcanism in southern Eritrea is more than 10,000 years old the ash particles investigated here appears un-eroded, and are likely to have fragmented further during transport.

4. CONCLUSION

This investigation shows that the submitted sample basically consists of well sorted and well rounded aeolian (i.e. wind deposited) fine sand, 0.1-0.3 mm in grain size, mixed with unsorted glassy and vesicular fragments of volcanic ash (cinder). All analyses reveal a detectable amount of salt reflecting either arid conditions or closeness to sea.

The current study is descriptive. No conclusions as to whether the submitted sample can explain the damages incurred on the ROFI equipment in Eritrea are presented. It is, however, clear that the ash particles are both mobile, due to their vesicularity and high surface to weight ratio, and in many cases forms grains of sharp glassy fragments. Thus, it is possible for fairly large ash particles to get carried by the wind, and the sharp edged grains will be more erosive than rounded ones. The chemical and mineralogical composition of the aeolian sand and ash particles does not imply any other detrimental problems to either health or equipment.

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