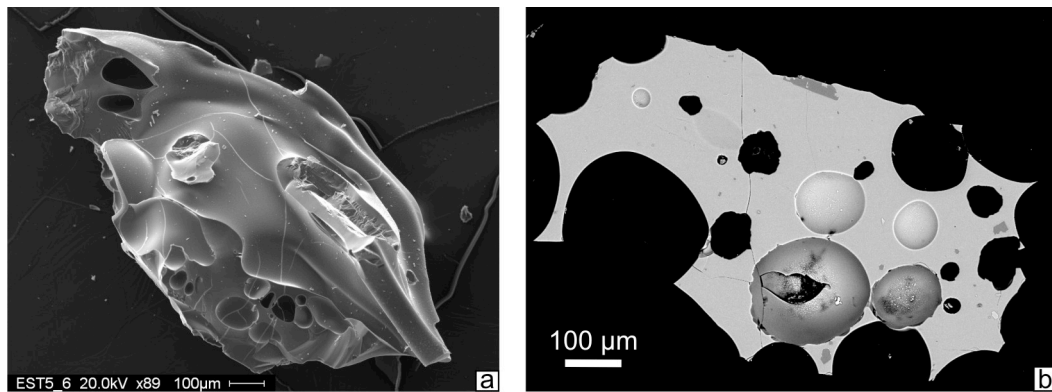


Supplemental material:
IDENTIFYING RECYCLED ASH IN BASALTIC ERUPTIONS

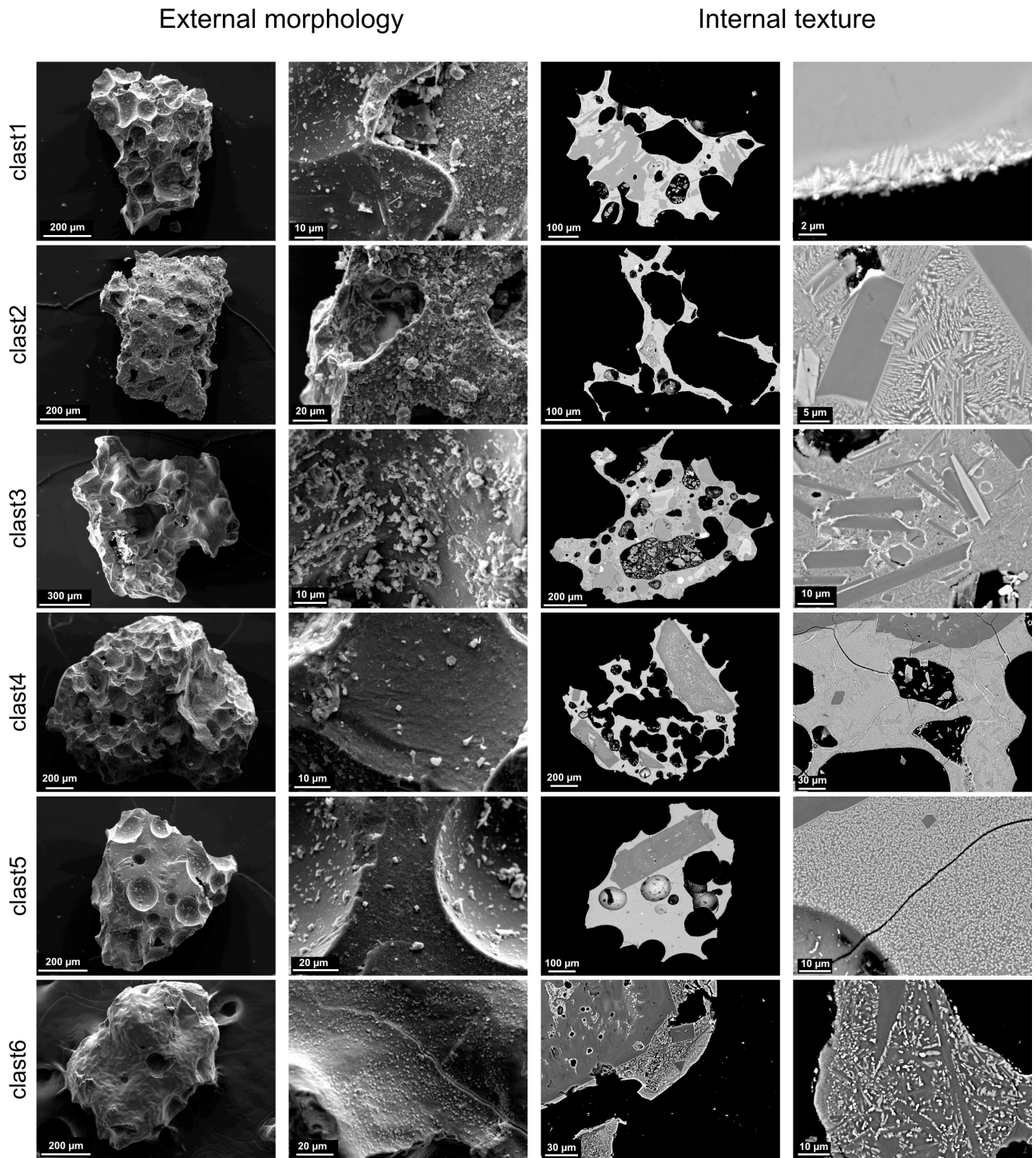
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Contents

In this section we will show the morphological and textural features of Type A, unmodified, primary juvenile clasts and highlight the close relations that exist, in recycled clasts, between external morphology and groundmass texture, by showing a series of SEM images.



Supplementary Figure S1. SEM images of a Type A clast, characterized by a fluidal external surface (a) and a glassy groundmass (b).



Supplementary Figure S2. SEM images of external morphology and internal textures of selected ash clasts, part of them are already shown in Fig.2 (see the text), as example of external morphology modified during recycling.

Clast1 belongs to the Gaua 2009 sample. In the text we consider this fragment as an example of altered external surface of a clast with an irregular shape. We show here its groundmass glass, where crystals of oxides are present on the external border, following recycling at low temperature and/or for short lapse of time. Under the stereomicroscope Clast1 appears glittery.

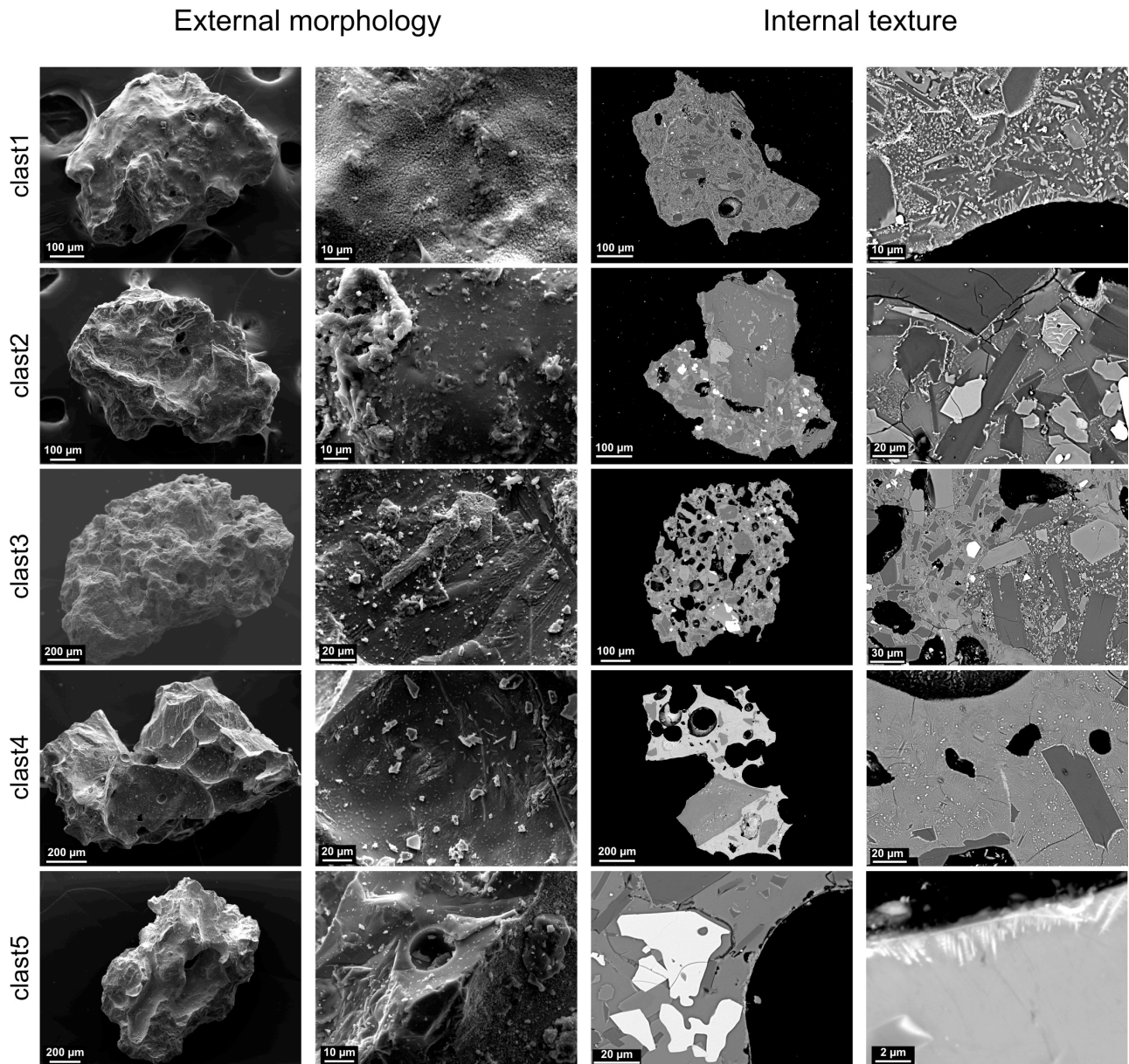
Clast2 also comes from the Gaua 2009 sample. It is characterized by a pre-existing smooth external morphology, which is covered by a sort of encrustation. In thin section, vesicularity does not show evidence of modifications while the groundmass appears totally crystallized with spherulites and dendritic crystals. Under the stereomicroscope Clast1 appears dull.

Clast3 is from EP2 sample and is also presented in the text as an example of recycled clasts with smooth external surface. The internal texture is characterized by incipient nucleation of microlites around pre-existing plagioclase and leucite. Matrix glass contains acicular microlites (up to 95%). This clast appears glittery.

Clast4 is from EST14 sample and shows an irregular shape, with tiny mounds projected on the external surface. It remains difficult to assert if vesicularity of the clast was modified after the fragmentation, but, in thin section, it is clear that pre-existing fractures, highlighted by the presence of oxides, are now sealed; moreover spherulites appear in the groundmass that starts to devitrify. This clast is dull to the naked eyes.

Clast5 (EST8 sample) is presented in the main text as an example of blocky fragments with altered external surface (tiny mounds). Here we show that its groundmass is incipiently devitrified, resulting in a glitter luster.

Clast6 (ETNA2013 sample) is shown in the text as it presents wrinkles and fractures on the external surface, associated with crystallization of microlites. The groundmass of the clasts appears totally crystallized suggesting a long time exposure to high temperature conditions. This clast is red dull in appearance.



Supplementary Figure S3. SEM images of external morphology and internal textures of selected ash clasts, part of them are shown in the text (Fig.3), because they present groundmass features diagnostic of thermal recycling.

Clast1 (ETNA 2013 sample) is indicated as an example of clasts with reduced vesicularity and presence of oxides along pre-existing plagioclase. Here we show that its external morphology is smoothed (start of sintering?) and totally crystalline. This clast shows a dull luster.

Clast2 (ETNA 2013 sample) presents an overall smoothed external surface, characterized by sintering of pre-existing adhering dust. The groundmass is still glassy, but the occurrence of oxides on the external rim of the clast and on plagioclases, the nucleation of microlites in groundmass and the subsolidus transformation of olivine microlites (in the top right of the picture) are clear evidences of recycling. Under the stereomicroscope this clast appears glittery.

Clast3 (ETNA2002 sample) is presented in the text as an example of collapsed and reduced vesicularity. Actually the external morphology is smoothed and totally crystallized resulting in a dulling of the luster.

Clast4 (EST8 sample) is shown in Fig 3 (see the main text) as its groundmass is characterized by plumose and spherulitic microlites. The same features are also present on the external surface, associated with the presence of tiny mounds. The combination of these two types of microlites produces a dull appearance.

Clast5 (ETNA 2002 sample) is shown in the main text as it presents oxides on the external surface. Here we can see that the whole external surface of the clast is possibly smoothed and the walls of the bubbles are characterized by a fine crystallization. At the stereomicroscope, this clast appears partially glittery, with the redness confined around the bubble walls.