3D Modeling from X-ray computed tomography images: Crystals properties in Magma

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Experimental samples of basaltic composition were created in laboratory conditions at various temperatures, synthetic basalt samples being obtained by controlled cooling to reach 40% of crystallization [1]. This allowed *in-situ* observations of plagioclase and olivine crystals using X-ray micro-tomography beam lines at SPring-8 [2]. Despite grey levels between glass and crystals being close, and crystals being mostly inter-connected, analysis of crystals properties in the synthetic magma was rendered possible through automatic processing using usual software for CT treatment.

Throughout this study, crystals have been digitally modeled using the numerical platform 3DEXPERIENCE© developed by Dassault Systèmes (DS) and permitting samples reconstructions to be conducted in 3D. Models were generated manually by analysing successive samples images to observe all crystals and assess how they were spatially organized. Using the software, sections of crystals were drawn and linked together to build crystal shape in 3D until each individual crystal in the system was modelized.

As a result, the 3D imaging (figure 1) facilitated the study and understanding of crystals shapes, axis measures, volume, connectivity, crystalinity, CSD (Crystal size Distribution), texture and interaction between mineral species and magma. In parallel shape factors are reassessed close to reality and, crystals agglomerations are modelized and estimated.

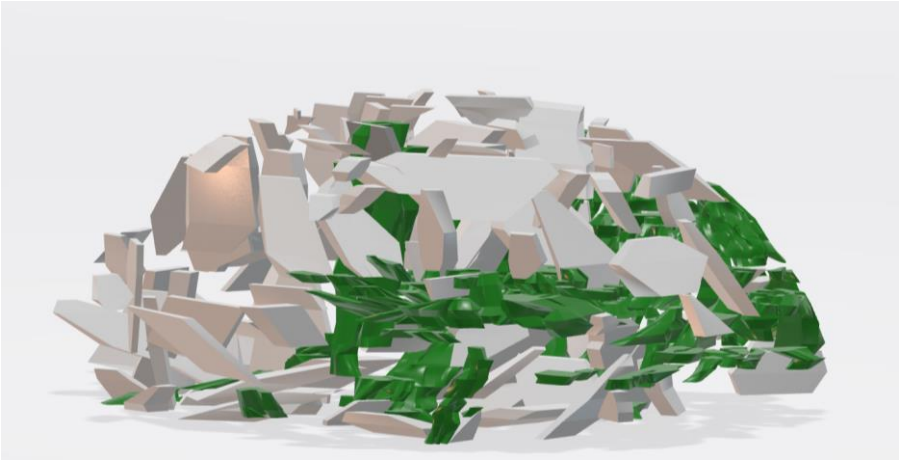

Figure 1: 3D modeling of an experimental sample with mineral species in grey and green.

Besides, 3DEXPERIENCE© provides many other advantages like density calculation, crystals orientation and strains representation. This method and its results have been compared to automatic visualization softwares in order to estimate their different approximations and errors.

References

[1] E. Pupier, S. Duchêne, and M.J. Toplis. *Experimental quantification of plagioclase crystal size distribution during cooling of a basaltic liquid*, Contribution to Mineralogy and Petrology, 155,555-5570, (2008).
[2] E. Ottavi-Pupier, B. Darde, L. Monnier, S. Okumura, A. Tsuchiyama, M. Uesugi, K. Uesugi. *CSD, crystal shape and connectivity in synthetic basalt from 3D reconstruction by X-ray CT image*, Mineralogical Magazine, 77(5), 1902, (2013).