Aerosol mass spectrometer constraint on the global secondary organic aerosol budget

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The budget of atmospheric secondary organic aerosol (SOA) is very uncertain, with recent estimates suggesting a global source of between 12 and 1820 Tg (SOA) a^{-1}. We used a dataset of aerosol mass spectrometer (AMS) observations and a global chemical transport model to produce top-down constraints on the SOA budget. We treated SOA formation from biogenic (monoterpenes and isoprene), lumped anthropogenic and lumped biomass burning volatile organic compounds (VOCs) and varied the SOA yield from each precursor source to produce the best overall match between model and observations. Organic aerosol observations from the IMPROVE network were used as an independent check of our optimised sources. The optimised model has a global SOA source of 140 ± 90 Tg (SOA) a^{-1} comprised of 13 ± 8 Tg (SOA) a^{-1} from biogenic, 100 ± 60 Tg (SOA) a^{-1} from anthropogenically controlled SOA, 23 ± 15 Tg (SOA) a^{-1} from conversion of primary organic aerosol (mostly from biomass burning) to SOA and an additional 3 ± 3 Tg (SOA) a^{-1} from biomass burning VOCs. We used a dataset of 14C observations from rural locations to estimate that 10% of our anthropogenically controlled SOA is of urban/industrial origin, with 90 Tg (SOA) a^{-1} (90%) most likely due to an anthropogenic pollution enhancement of SOA from biogenic VOCs.

Differentiation of impact-melt sheets: Evidence from Manicouagan with implications for the Moon

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Introduction

Recent exploration drilling of the late Triassic, ~80-90 km rim-diameter Manicouagan impact structure, Canada, has yielded ~18 km of core from 38 locations, three holes of which are >1.5 km deep [1]. This new data provides unprecedented insight into the internal structure and composition of a relatively large crater. Complemented by an ongoing 10-year (2006-2016) ground-based research project (the Manicouagan Impact Research Program: MIRP), the goal is to better understand impact crater tectonics and the formation and evolution of impact melt bodies. This is being achieved through training undergraduate, MSc and PhD students, in collaboration with PDFs and Research Scientists, as well as colleagues working internationally.

Impact melt characteristics – new revelations

The drilling program has revealed that the Manicouagan impact melt sheet is not of uniform thickness (previously considered ~300 m thick), but includes considerably thicker sections: up to ~1000 m of clast-poor impact melt, underlain by ~400 m of clast-rich impact melt [2]. These thicker sections of melt comprise a monzodioritic Lower Zone (~500 m), a quartz monzodioritic Middle Zone (~250 m) and a quartz monzonite Upper Zone (~275 m). This is only the second impact structure known to unequivocally exhibit differentation (previously, Sudbury was the sole exemplar). Geochemical investigation of the thicker melt sheet sections indicates that they formed via fractional crystallization [2].

Impact melt sheet-footwall relations

Drilling results, coupled with field work, have revealed that the interface between the impact-melt sheet and footwall is not flat, but exhibits more complex 'topography', which strongly implicates the presence of fault-controlled structure [3]. This new evidence allows the construction of hypothetical cross-sections, which provide insight into central peak and terrace collapse formation mechanisms for complex craters on Earth, the Moon, Mars and beyond.

[1] Spray *et al.* (2010) *Planet. Space Sci.* **58**, 538–551.
[2] O'Connell-Cooper & Spray (in press) *JGR Solid Earth.*
[3] Spray & Thompson (2008) *Met. Plan. Sci.* **43**, 2049–2057.