The Mayon Volcano (Philippines) plumbing system: Insights from crystal zoning patterns and volatile contents

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Mayon is a persistently degassing volcano, producing vulcanian-strombolian eruptions every few years, and perhaps a plinian eruption every century. We investigate the plumbing system beneath Mayon using phenocrysts, microlites and melt inclusions, which record processes in the magma chamber and conduit. We also inspect matrix glass composition to relate the magmatic history all the way to the last stages of cooling during an eruption.

Eruptive products of Mayon are consistently basaltic andesite in composition. Petrological data for this study are derived mostly from bread-crust bombs of the 2000 eruption, which have inclusions of up to 40cm in size. These inclusions have the same bulk composition and phenocryst populations as the host rock, the difference lies only in their more crystalline matrix. The coarse microlites in the inclusions imply relatively slow degassing rates, revealing an upward magma movement slower than that of an eruption, as would occur during convection in the conduit.

Similarity in the phenocrysts of the host and inclusions indicate the same magma at depth. Plagioclase phenocrysts show complex patterns, from oscillatory zoning to pervasive sieve textures that may occur multiple times in a single crystal. The most calcic end member resorbs more sodic zones, forming geometrically complex zones rich in glass that result to the sieve texture. Clinopyroxene and orthopyroxene phenocrysts are also zoned, but show less complexity than the plagioclase. In many cases, pyroxene cores are more iron-rich than the rims, although iron-rich outermost rims are also common. These textures and zonations can be explained by the mixing of at least two end-members in the reservoir, one more primitive (An80, Mg#75) and probably more volatile-rich than the other (An60, Mg#65). The extent to which these patterns reflect a single – versus multiple – replenishment, is unclear.

Fe-Mg diffusion modelling in pyroxenes suggests timescales of less than 10 years between mafic injection and subsequent eruption. Preliminary volatile data from melt inclusions in tephra fall deposits of the 2000 eruption yield source depths of about 9km. Additional volatile analyses of different Mayon eruption deposits are underway to further characterise the inner workings of the volcano.

Titan tholins: A synopsis of our current understanding of simulated Titan aerosols

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What Are Tholins?

Since the term 'tholin' was first applied by Carl Sagan to the dark organic residue formed from gas phase activation of cosmically relevant mixtures, [1] many hundreds of papers have been published on the generation and/or analysis of this material. In particular, the similarity of tholin optical properties to those of the Titan haze has caused new investigations into laboratory simulation of these aerosols. Much has changed both in terms of our abilities to simulate conditions of the Titan atmosphere and to analyze the samples produced.

We will summarize work involving laboratory analogues of Titan complex organic material (tholins) in the context of recent discoveries. Our current understanding of Titan as a prebiotic system is constantly evolving, and recent data from the Cassini-Huygens mission has greatly improved physical and chemical constraints on models of the atmosphere. However, laboratory experiments are still necessary to provide critical insight for defining the next series of *in situ* experiments to perform on Titan, which will better elucidate processes occurring in the atmosphere and on the surface.

Are Any Tholins Titan-Like?

A variety of complex organic aerosols produced using gas phase activation techniques (cold plasma/corona discharge, hot plasma/spark discharge, UV irradiation, etc.) have all been labeled 'tholins', despite the fact that their physical and chemical properties can be enormously different. This variability begs the question: which, if any, of these tholins are truly Titan-like?

We examine various tholin generation methods and compare the organic material produced to the expected composition of the aerosols in Titan's haze and precipitates settled onto the surface. Tholins are assessed in terms of their optical properties, physical characteristics and chemical composition. We also investigate the possibility of additional chemistry occurring on the surface of Titan, and examine potential *in situ* analysis techniques that could be used on future landed missions to search for evidence of this chemistry. Finally, we develop a metric to classify tholins based on how effectively the relevant properties of the Titan atmosphere (temperature, pressure, energy density, etc.) are replicated during tholin formation. This metric should also help inform the next generation of chemical protocols and instrumentation for use on the surface or in the atmosphere of future Titan *in situ* missions.

[1] Sagan (1979) *Nature* **277**, 102-107.