

## **Mawson Formation at Coombs Hills, Antarctica Records Conditions Within a Surtseyan Vent Complex**

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The Mawson Formation at Coombs Hills, Antarctica is inferred to record tephra-jet eruptions from a huge, sub-aerial vent complex. Mawson Formation rocks comprise mainly massive tuff breccia (80% vol.), include a high proportion of accidental lithic fragments, carryrafts of bedded pyroclastic rock and country rock, and are intruded by and intermingled with irregularly shaped dikes and sills with local peperite. Massive tuff breccia deposits crosscut one another along steeply dipping to sub-vertical zones that juxtapose tuff breccia of contrasting componentry and grain size. Metres-scale dikes and pods of coherent basalt grade, via peperite contacts, into rafts of undisrupted country rock, or into surrounding tephra consisting of sedimentary debris mixed with glassy basaltic clasts. The Mawson succession is capped by planar and cross-bedded tuff, lapilli tuff and tuff breccia, which comprises 10% of the Mawson deposits exposed at Coombs Hills. Componentry suggests quarrying of country rock from relatively shallow levels (? 700 m).

The Mawson Formation at Coombs Hills is interpreted to represent deposits typical of those formed within Surtseyan vents. Variably vesicular palagonitic fragments suggest magma-water interaction, which we infer was driven by interaction of basalt with water hosted in porous country rock and vent filling tephra. Sub-vertical zones of tuff breccia in crosscutting relationships with other massive tuff breccia are inferred to have been formed by jets of tephra passing through the unconsolidated vent filling tephra. We further infer that discrete explosions or sets of explosions initiated within the vent-filling tephra propelled these jets of tephra through overlying vent-filling tephra, and that on at least some occasions the jets vented to the atmosphere to form typical subaerial tephra jets. Many tephra jets are inferred to have died out in vent fill before breaching the surface, leading to mixing, and recycling, of clasts which never escaped the vent. Some tephra lofted subaerially was deposited by fall from tephra jets or derivative pyroclastic density currents beyond active vent sites, but wall collapse during broadening of the vent complex resulted in destruction of most of these pyroclastic deposits. Enlargement of the vent complex was accomplished by lateral quarrying of poorly consolidated, fragile country rock, which collapsed along vent margins. Collapse blocks were subsequently digested as a result of shaking and shearing as vent-fill tephra moved downward into the vent in response to ejection

of material from explosion sites deeper in the vents. Digestion of these blocks added both mass and additional external water to the vents as they erupted. Spatial and temporal heterogeneity in availability of external water led to a variety of eruptive styles at different times and depths and at different ephemeral vents within the Coombs Hills vent complex.

Implications for volcanic processes are (1) that recycling of water, as well as recycling of pyroclasts, is important in some Surtseyan vents; water recycling can facilitate development of large-volume hydrovolcanic systems fed by groundwater even in deposits of modest permeability; (2) that the proportion of recycled water increases with vent size; and (3) Surtseyan vent-filling deposits can contain many clasts, fragmented during explosions and transported within vent-filling tephra, which never escaped the vent to form subaerial deposits of pyroclastic debris.