THE TUFF RINGS OF SOUTH EAST AUSTRALIA AND THE SURFICAL DEPOSITS OF MARS: A CAUTIONARY TALE. J.H.J. Leach, Department of Geomatics, University of Melbourne, Parkville, Victoria 3010, Australia, leach@unimelb.edu.au.

Introduction: A maar is a broad shallow volcanic crater formed when magma interacts with ground water or permafrost to cause an explosion. Because of its explosive formation the crater is very similar in form to an impact crater. Since ground ice is thought to be common on Mars, it could be expected that maar type eruptions also occur there [1]. While this has consequences for crater count chronology, maar eruptions also generate specific types of volcanic deposits which will need to be identified as we explore the Martian surface. In this, the study of available terrestrial analogs is important. In this, the maars of the volcanic province of South East Australia represent an important set of analogs.

The volcanic province of South East Australia consists of an interpolate, continental basaltic plain. The original eruption points of the majority of the basalt flows are obscure but later stage eruption points include shield volcanoes, scoria cones and tuff rings. The tuff rings are a type of maar and they exhibit a particular sequence of eruption events and deposits which contain many of the same features as sedimentary deposits. The possibility that layered deposits with cross bedding could be the results of volcanic emplacement needs to be considered when interpreting image data from Mars.

It is not here suggested that any of the layered deposits seen in crater walls by the current rovers are in fact maar deposits but only that this is a possibility which needs to be further explored.

Maar Formation: None of the maars of the SE Australian volcanic province were formed by a single explosive event. Rather, they are the result of a particular eruption sequence which was the result of persistent, if fluctuating, interaction between the magma and the ground water. There are three major phases to this sequence.

1. The first is an initial explosive phase where the crater is formed and magmatic dominant material is deposited locally about the vent, probably by ballistic emplacement.

2. The second is a period of base surge eruption where ground hugging flows of volcanic gas, steam and entrained country rock and magma flow out from the vent. These eruptions can happen many times, resulting in extensive, layered volcanic deposits. These consist of finely interbedded units of coarse magmatic material and fine grained country rock.

3. The final phase is dominated by ash fall with most of the ash being composed of entrained country material. This ash can cover an extensive area and the eruption was gentle enough that the distribution of the ash is heavily influenced by the prevailing wind. In places these can also be some minor and very localized ballistic and pryroclastic emplacement associated with this phase, resulting in magmatic dominated deposits dipping into the crater. Eruptions in this phase also can occur many times, resulting in fine, layered sediments which were initially mistaken for lacustrine deposits.

Layered tuff deposits from Lake Coragulac showing the first and third stages of eruption.

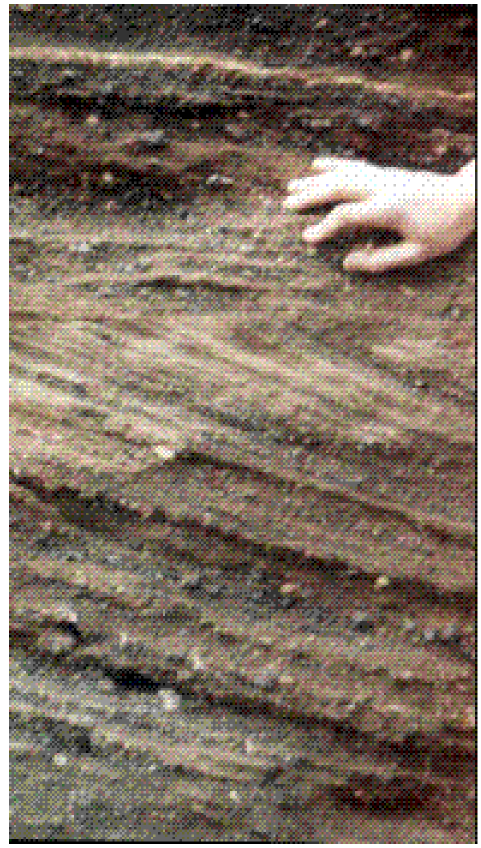
Maar form: The tuff rings, or maars, are low lying ramparts of pyroclastic material surrounding wide but comparatively shallow craters. The typical form has a steep slope or cliff on the inside of the crater and a very gentle (<4 degrees) slope on the outside which gradually merges with the surrounding countryside. The flattened floors of the craters lie at or only slightly below the level of the surrounding country [2]. It is most unlikely that this crater form could be mistaken for a fresh impact crater, the vertical profile is too subdued, but it could very easily be mistaken for a weathered or degraded one.

The deposits forms from these eruptions not only display complex interbedding but, since the pyroclastic flow is essentially just a fluid moving across an unconsolidated sediment, you also get the development of bedforms such as dunes – typically with an approximately two meter wavelength. Finer scaled ripples are sometimes observed in the fine grained beds. Subsequent eruptions mean that later pyroclastic flows can erode and cut across the deposits of earlier flows – leading to the development of coarse cross-bedding. As well, these materials are being erupted via superheated steam. This means that they are being chemically altered before, during and after the eruption.

All of this, the finely intebedded units, the bedform dunes, the coarse bedding and the chemical alteration, could be taken to be indications of a sedimentary rather than a volcanic deposit. The one key difference is that these deposits are very poorly sorted although even here, flood deposits or periglacial deposits could look similar. This the is a cautionary tale. The possibility of maar type deposits needs to be considered as an alternative to sub-aqueous deposition.

Base surge deposits from Lake Purdigulac showing dune formation.

References: [1] Peet, V.M. et al.(2006) *Terrestrial volcanic and impact analogs to Martian small craters: Utilizing remote sensing and field-based datasets to analyze formational and sediment transport processes.* Lunar Planet. Sci. Conf. XXXVII, abs. No. 2323. [2} Joyce, E.B. (1988) *Newer Volcanic Landforms* in *Geology of Victoria*, Douglas, J.G. and Ferguson, J.A. (Eds.), Victorian Division, Geological Society of Australia, Melbourne.



Cross-bedding in Lake Purdigulac deposits.