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Probable recent water/lava source fissures in the Cerberus Plains: stratigraphic and crater count age constraints

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1. Introduction

The Cerberus Plains have received increasing attention in recent years due to evidence from high-resolution imagery that they are some of the youngest surfaces on Mars. The plains are incised by large outflow channels, possibly as recently as 20Ma in the case of Athabasca Valles [2]. These channels are generally thought to be water-carved [1,3], though it is possible they were incised by turbulent lava [8]. As recently as 10Ma or less [5] both the channels and the plains around them are proposed to have been draped with lava [7].

Thus the recent activity forming the Cerberus Plains probably required large volumes of both water and lava. The problem which arises is a source. Cerberus Fossae have been suggested as the source of the Athabasca Valles outflows [3,6], but topographic and stratigraphic issues have arisen which make this unlikely: for example, a streamlined island spans the fossa where water and/or lava is said to have originated [4]. No other specific sources have been identified. As plains volcanism often obscures its fissures, sources should be searched for in features elevated above the plain.

New HiRISE images have shown just such a feature: a wrinkle ridge south of Cerberus Fossae incised by a series of fissures. Every fissure has associated channels and deposits indicating outflow onto the plains surrounding the ridge. Until now, the stratigraphic history of these features was poorly known, with Tanaka et al.'s [9] geological map considering the area only on the broadest scale.

This study produces small-scale geomorphological maps to establish the stratigraphic relationships between the fissure-sourced outflows and the plains surrounding the ridge to test the hypothesis that they were the source of the plains material. Crater counting is also conducted to supplement stratigraphic observations and give tentative ages.

2. Methods

2.1 Geomorphological Mapping

Maps were produced for the area 156.8°E, 6.73°N, and 158°E, 8.01°N. Small scale maps were based on Mars Reconnaissance Orbiter's HiRISE images, and a Regional Map was based on its CTX images. As orbital imagery cannot be used to directly investigate geology, geomorphological mapping was performed.

A stratigraphic tree was produced for each map indicating superposition and erosive contacts between units.

2.1 Crater Counting

All craters >16m diameter were mapped. These were counted for units of specific interest and the results were binned using the scheme of Hartmann & Neukum [5]. Crater size-frequency curves of this data were created, plotting crater count per km^2 against diameter bin. These curves were compared with Ivanov isochrons to give tentative absolute dates.

3. Relationships of fissure-sourced activity with regional plains.

3.1 South of the ridge

Superposition of deposits and incision by channels show that outflows from fissures at the west and centre of the ridge (F1, F2) flowed onto the plains to the south (Ps in Fig. 1). Crater counting indicates that resurfacing of these plains continued throughout the period fissure-sourced material was being deposited onto them.

3.2 South-East of the ridge

A large-scale regional flow (Pse, Fig 1.) in the south-east overlies both the southern plains and channels formed by outflow from the far east of the ridge (F9).

However, the very latest activity from broad collapse fissures in the south (F6, F7) overlies Pse. Pse tentatively dates to 1-10Ma on crater-counting data and appears have flowed in from the east. On the basis of its texture and morphology, it is a lava flow.

3.3 North of the ridge

Outflows from F3 and F4 incised into and deposited onto earlier plains material immediately to the north of the ridge. However, these units are in turn overlain by a lower albedo regional flow unit, Pn (Fig 1.) This appears to flow in from the north. It has the morphological characteristics of a lava flow.

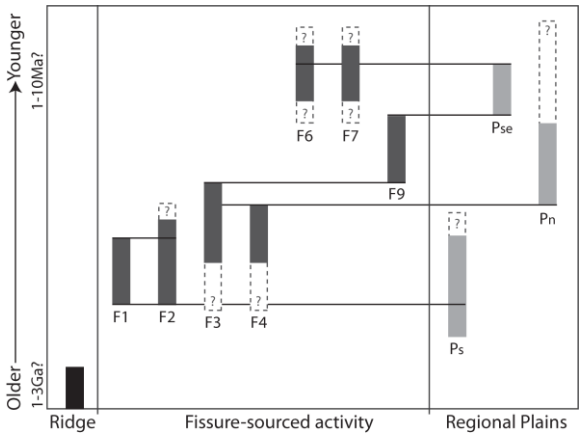

Figure 1: Stratigraphic relationships of fissure-sourced activity to regional plains based on mapping and crater counts. Fissures (F) are numbered west to east. Plains (P) are named by regional location.

6. Summary and Conclusions

- In the south-west to south of the study area, fissure-sourced flow deposits overlie the regional plains material. They are therefore the source of the most recent deposits forming these plains.

- Regional deposits to the south-east, probably lava flows, overlie some fissure-sourced channels but are overlain by the latest deposits from the fissures in the south.

- Regional flow units in the north, also probably lava, overlie the northern fissure-sourced units.

- Part of the Cerberus Plains is therefore sourced from the fissures in this wrinkle ridge. However, they are not the source of large-scale regional lava flows. The source of these flows is to the north and east of the study area.

- Outflow activity from the fissures was recent, and may have been within the last 1-10Myr.

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