PRIORITIZING CANDIDATE SOURCE CRATERS FOR MARTIAN METEORITES. J. S. Hamilton[1], C. D. K. Herd[1], E. L. Walton[1,2], and L. L. Tornabene[3], [1]Department of Earth and Atmospheric Sciences, 1-26 Earth Sciences Building, University of Alberta, Edmonton, Alberta, Canada, T6G 2E3, jhamilto@ualberta.ca, [2]Department of Physical Sciences, MacEwan University, Edmonton, Alberta, Canada, [3]Centre for Planetary Science and Exploration/Department of Earth Sciences, University of Western Ontario, London, Ontario, Canada

Introduction: Near-surface units adjacent to recent impact craters are the origin of martian meteorites [1, 2]. The process of establishing potential candidate source craters involves identifying the most well-preserved craters occurring on Amazonian-age igneous terrain, within the range of permissible sizes based on impact modeling [3]. Initial queries based on a database of the best-preserved craters on Mars [4] return <20 possible candidates for a selection of igneous martian meteorites [5]. Of these, the 8 most well-preserved craters were chosen for further analysis [3].

Candidate Craters: The 8 craters as identified by [3] are potential sources for any of the four igneous martian meteorites (Zagami, Tissint, Chassigny, NWA 8159) analyzed by [5]. In this study, the likelihood of these 8 craters as being source(s) of the aforementioned meteorites or the group of ~1.1 Ma ejection age meteorites [6], is evaluated. Beyond occurring on Amazonian igneous terrain and having a well-preserved interior morphology, this study examines additional requirements including ejecta characteristics and nearby volcanic features. These criteria are used to rank the craters in terms of meteorite source probability. We use a combination of visible (CTX, HiRISE, HRSC) and thermal inertia (THEMIS) imagery. Unnamed craters are identified according to the database by [7].

Zunil. Zunil is a ~10 km diameter crater previously identified as a potential meteorite source crater based on its well-preserved character and visible thermophysical rays [4, 8, 9]. It is located in the southeast corner of Elysium Planitia (MC-15, [10]) within Cerberus Fossae, a series of fissures formed during extensive late Amazonian volcanic activity [10]. Surface flows attributed to the southern portion of Cerberus Fossae are as young as 8 Ma [11] while the next youngest volcanic unit is 125-500 Ma and found at least 20 m below the surface [12, 13]. Zunil's multi-layered ejecta blanket is symmetrical and fills several hectometer-scale craters. [14] note a small population of decameter fresh impacts on the ejecta and crater floor; indeed, the crater is the youngest of major impacts in Elysium, dated at 0.1-1 Ma [14, 15]. Narrow, sinuous lava flows and kilometer-scale tholi are observed around Zunil but thick dust coverage hinders mapping, especially to the north.

Corinto. Like Zunil, the ~17 km-diameter Corinto crater occurs within Elysium Planitia (MC-15, [10]), ~500 km SW of Elysium Mons and SE of Hyblaeus Fossae. Chaotic grabens and fissures surround Corinto. Lobate lava flows are distinguishable trending radially from Elysium Mons. These flows are crosscut by the radial ejecta and are significantly thicker than those found adjacent to Zunil. Older, degraded craters occur throughout the ejecta, ranging from a few meters to >1 km in diameter. Corinto is the second youngest crater in Elysium Planitia, with an age of 1-9 Ma [14, 15].

Tooting. Tooting crater is the largest of the 8 studied craters (D = 29 km), found in the Amazonis region on flat lava plains on the western flank of Olympus Mons (MC-8, [10]). Lobate lava flows trending south-north that are late Amazonian in age dominate Amazonis Planitia and extend for hundreds of kilometers throughout the plains [10]. Tooting's ejecta blanket contains dozens of superimposed impacts and has an age of ~2.9 Ma +- 0.3 Ma while the surface it sits on is 240-375 Ma [16].

09-000015. Crater 09-000015 is the first of 2 candidate craters in the Tharsis region (MC-9, [10]); mapping of this crater was presented by [3]. It is situated NE of Ascraeus Mons on volcanic plains dominated by lava flows originating from this volcano. An arc shaped graben is crosscut by lobate lava flows and catenae are observed to the east of the crater. The ejecta is asymmetrical and blankets both the graben and volcanic flows [3]. Significant dust coverage obstructs accurate spectral data [17] and nearby surfaces have not been dated. A single, ~0.5 km diameter crater sits on the western portion of the ejecta and pre-dates crater 09-000015 based on infilling of this crater by the ejecta.

09-000007. The second Tharsis candidate crater, 09-000007 is found NW of Ascraeus Mons on the southern edge of Ceraunius Fossae [10]. The crater is comparable in size to crater 09-000015; however, 09-000007 has additional notable volcanic features. Ceraunius Fossae is a Hesperian age extensional fault system [18]; these faults lie directly underneath crater 09-000007 and show significant degradation [19]. A set of Amazonian/Hesperian lobate flows extending from the set of tholi directly NW of the crater travel northwest-southeast crosscutting remnants of Ceraunius Fossae and are themselves crosscut by the crater [10]. The surface surrounding and including the ejecta is heavily cratered, but no recent impacts post-dating crater 09-000007 are observed.

Domoni. Domoni is approximately halfway between Alba Mons and the Milankovic crater within Diacria (MC-2, [10]). It is ~14 km in diameter and falls within an area influenced by elongate, lobate lava flows and lava tubes from fissures and vents on the NW flank of Alba Mons [20]. Nearby flows have not been dated, but preliminary work on Alba Mons suggest volcanic activity as recently as ~1.1-1.5 Ga [21]. In addition to lava flows, a degraded graben trending in the same direction is observed on the northern side of Domoni, and long, straight ridges radiate outwards from the crater rim to the edge of the ejecta. The ejecta blanket is well preserved with multiple layers distinguishable and infilling a ~4 km diameter crater on its southwest corner.

03-000082. Directly on the northern flank of Alba Mons is crater 03-000082 (MC-3, [10]). This crater is ~21 km in diameter, located near a myriad of volcanic features including the Alba Mons caldera and catenae. Kilometer-thick extensional faults and grabens trending 100s of kilometers towards the NE [10] are also observed. The flows that are crosscut by the crater cannot be sourced to specific vents, fissures, or the caldera, hampering age dating as the caldera itself has an age of activity at ~3.4 Ga but the fissures on the flanks may have been more recently active [22]. Three ~4 km diameter craters and several meter-scale craters are observed in the ejecta but pre-date it as ejecta material is observed within the craters. The ~4 km crater on the southwestern side of crater 03-000082 is the most well-preserved of these 3 craters, with a well-defined interior morphology suggesting preservation of crater-related pitted material [4, 9], which could be confirmed using HiRISE.

03-000205. ~400 km to the south of the Alba Mons caldera, directly within Ceraunius Fossae, rests crater 03-000205 (MC-3, [10]). It is the smallest of the western candidate craters (~12 km diameter) and is encircled by catenae, fractures, and volcanic depressions [10]. The radial ejecta filled surrounding impact craters the latter ranging from 0.1-1.6 km diameter. Lava flows trending primarily north-south are observed but are difficult to map due to the dominance of nearby fractures.

Prioritization among the candidate craters: We assess meteorite source probability with two methods and then bin the eight candidate craters into groups based on fulfillment of the selection criteria (Table 1). Placement of a crater in a lower priority bin does not rule it out as a potential source of martian meteorites. The first method is relative age dating to define the youngest, most well preserved crater using preservation of pitted material [4], pre and post-dating impacts on the ejecta, and presence of thermophysical rays [9]. Our other criterion is the presence of nearby, mappable lava flows and whether flows are visibly crosscut by the ejecta (e.g. [3]).

Table 1. Priority bins for further analysis of candidate source craters.

Priority	Crater	
1	09-000015	09-000082
	09-000007	Tooting
	Domoni	
2	Zunil	03-000205
	Corinto	

Zunil is a young, fresh crater with thermophysical rays [9] but the nearby Cerberus Fossae volcanic units are too thick [11] for the sequence of thinly stacked flows suggested by [6] or likely too deep for the excavation model proposed by [5]. As Corinto is noted to be older by [15], placing it among the oldest of the eight craters, we assign it to bin 3 with Zunil. Crater 03-000205, while on an Amazonian/Hesperian mapped unit, has significant numbers of Hesperian age fractures on and around it and does not show evidence of continuous flows beneath the ejecta.

Crater 09-000015, crater 09-000082, crater 09-000007, and Domoni are assigned to bin 1: each of these craters have mappable volcanic flows and features, are not superimposed by more recent impact craters, and, based on preservation of interior morphology, are relatively young [4]. Lobate flows crosscut by the ejecta are observed in each of these craters; however, the degree of continuity of these flows underneath the ejecta is variable. Tooting fulfills our prioritization scheme and is noted to have remnants of stacked lava flows in the peak material [16]. Ongoing work includes identification of thermophysical rays and stacked lava flows in the crater wall, to further refine Table 1.

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