GLOBAL SCALE CHARACTERIZATION OF VENUSIAN AND TERRESTRIAL CALDERAS.

P. D'Incecco[1] and J. Helbert[1] (1) Institute of Planetary Research, German Aerospace Center, Rutherfordstrasse 2, D-12489 Berlin, Germany, piero.dincecco@dlr.de.

Introduction: In the present study we analyzed the areal and geometrical characteristics of Venusian calderas through a comparison with terrestrial analogs. Venus is a planet which had, and according to recent recent studies may still have a very active and most likely effusive volcanism [1-3]. Calderas are doubtless the most common structural expression of volcanic activity on terrestrial planets, thus we decided to perform a global scale characterization of these features in order to highlight eventual similarities and differences between the styles of volcanism on Venus and the Earth. We based our study on the data contained in two published lists of identified calderas for the Earth [4] and for Venus [5]. Building on the results obtained by previous works [4-21], we have calculated areal extent, eccentricity and their distribution over all the analyzed samples.

Methodology of data acquisition: We have focused our analysis on the data contained in two different databases, one database containing a total of 481 terrestrial calderas [4], and another database [5] containing all the 96 volcanic depressions so far identified on Venus. The first goal was to approximate the areal extent and the eccentricity for all the available samples. The latter we calculated from the semi-major and semi-minor axis of each caldera..For the Venusian calderas we approximate the areal extent by the area of an ellipse defined by the length of the semi-major and semi-minor axis.For the Terrestrial samples we used the values already calculated in the same way by [4]. We limited our study to 379 of the initial 481 terrestrial samples, because only for those the database contained complete information,.

The resulting dataset was partitionated in classes of areal extent (Fig.1) and eccentricity (Fig.2) to facilitate a direct comparison between Terrestrial and Venusian samples.

Results: The datasets for areal extent (Figure 1) and eccentricity (Figure 2) reveal shows some clear trends. The majority of terrestrial calderas have areal extents of less than 1000 km^2. Venusian volcanic depressions show much larger sizes, with the majority in the range between 1000 km^2 and 8000 km^2 (Fig. 1). After partitioning both Terrestrial and Venusian calderas in classes of areal extent, we could not identify any particular relation between these classes and their geographic distribution.

Dividing the obtained values in classes of eccentricity varying from 0% (circular shape) to 100 % (strongly eccentrical shape), we found that on both planets most calderas are characterized by a circular shape. Both planets also lack intermediate classes of eccentricity between 0% and 40% (Fig. 2). In other words, both Venusian and Terrestrial calderas show the same gap of morphologies, they are either approximately circular or they show an already moderately enhanced eccentrical shape, missing instead intermediate morphologic members. The classes of eccentricity, as much as the classes for areal extent, did not show any evident connection with their geographic distribution. They seem randomly distributed over the surface of the two planets.

Outlook: The preliminary results shown here indicate a clear difference in size between Terrestrial and Venusian volcanic depressions, with calderas on Venus generally much larger than calderas on the Earth. As it is generally assumed that the volume of a magma chamber has a direct influence on the final size of a caldera on the surface [12, 13, 15], the greater sizes of Venusian calderas might imply that the underlying magma chambers have much larger volumes than their counterparts on Earth. Geometry of the magma chambers has also a strong influence on the external morphology of a volcanic depression [8, 12]. On the base of previous studies made on Terrestrial calderas [4, 6-13], we assess that circular calderas 1) overlap approximately circular magma chambers and 2) are characterized by a standard tectonic background where only local stress fields due to the caldera formation process play a significant role. More elliptical caldera morphologies can be generally related to a number of factors such as the plain view geometry of the underlying magma chamber and/or the interaction of regional stress fields which tend to modify the surface expression of volcanic depressions from approximately circular to more elliptical geometries [8, 12]. The amount of data we analyzed is still not enough to clearly answer why we observe over both the planets the same gap in the classes of eccentricity, missing intermediate geometries between circular and extremely elliptical shapes. We need to extend the present dataset of Venusian calderas in order to make a more reliable comparison with volcanic morphologies on the Earth. The intial results encourage thinking that some theories used for explaining caldera formation processes on the Earth may be applied also for understanding similarities and differences with the style of volcanism on Venus.

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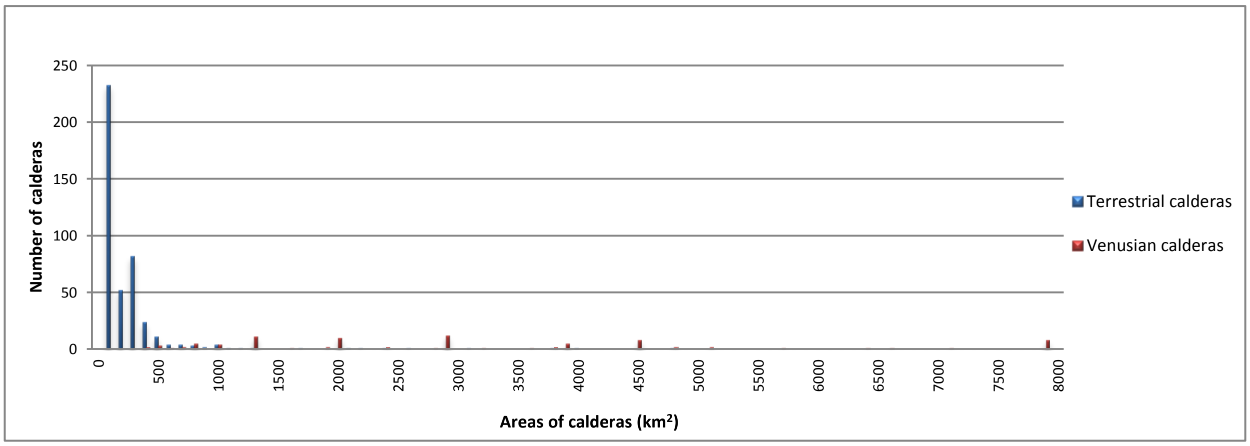
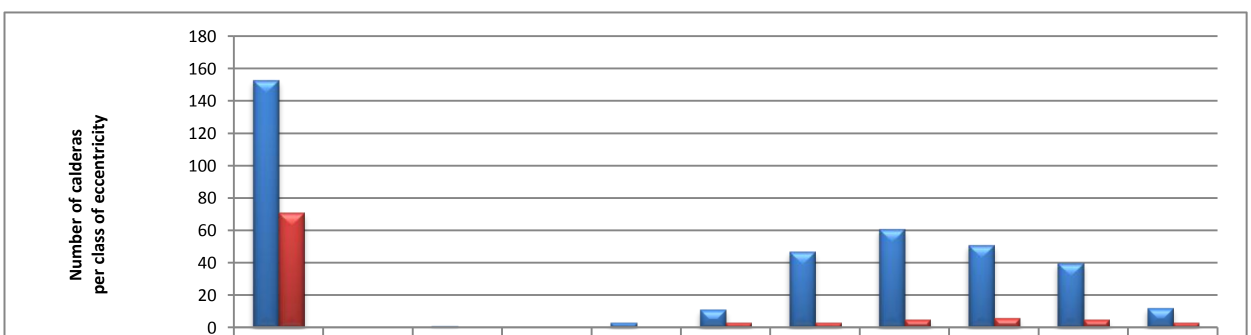


Figure 1 – Areal extent classes distribution of calderas on Venus (red) and on the Earth (blue).



	e = 0	0 < e ≤ 10	10 < e ≤ 20	20 < e ≤ 30	30 < e ≤ 40	40 < e ≤ 50	50 < e ≤ 60	60 < e ≤ 70	70 < e ≤ 80	80 < e ≤ 90	90 < e ≤ 100
Terrestrial calderas	153	0	1	0	3	11	47	61	51	40	12
Venusian calderas	71	0	0	0	0	3	3	5	6	5	3

Figure 2 – Distribution of eccentricity of Venusian (red) and Terrestrial (blue) calderas. Values of eccentricity are expressed in % and vary from 0% to 100%. Eccentricity e=0% indicates the geometric shape of circle while e=100 % indicates a parabola.