

Brief Description of the various crater types

Complex craters: are according to the standard model normal impact craters with a diameter larger than 20 km. They have terraced walls, a central peak or central mountains, partial landslides and outside the main crater a region with melted material that was ejected out of the crater as well as secondary craters.

Floor Fractured craters: FF craters are normal impact craters that have a distinct fissure / rille system on the crater floor. They usually have a diameter greater than 40 km and are almost exclusively on the outskirts of the large Moon Mare. Their origin can be briefly described as follows: while the lava flows flooded the impact basins there was also some magma pressed through cracks in the lunar mantle under these FF craters. Under the immense pressure of the magma, the crater floors were raised and bended. When the stress in the slow moving or already solidified lava inside the crater was too big, the fissures in the crater floor formed - usually concentrically in the rim of the crater. A prototype of this is the crater Pitatus in the southern region of Mare Nubium. Occasionally some lava was extruded through these fissures then, or as in the case of Alphonsus, there were some regions with pyroclastic volcanism and ash deposits. In principle, the FF craters are formed due to a combination of intrusive and effusive / pyroclastic volcanism.

Later - but nevertheless while the impact basins were flooded - the Mare shields in the center of the basin subsided under the immense weight of up to 5 km thick lava. Through this movement the FF Crater tilted towards the Mare center and the crater walls near the Mare center were flooded. FF-craters are old structures and were formed during the big lava floods in the period prior to 2.5 to 3.85 billion years ago.

Concentric Double Crater: On the front of the moon there are a small number of roughly 50 so-called concentric double craters. Their origin has been unclear, there are various different theories. The largest double craters, which are accessible with amateur telescopes, are Hesiodus A (east of Pitatus) and Crozier H in the northern part of Mare Fecunditatis. All other double crater structures are much smaller and / or lie too close to the edge of the moon, so that the dual structure can't be resolved with ground based telescopes because of the large perspective distortion.

Almost all of these craters lie in the outer regions of the Mare. Statistical investigations showed that they have a diameter of 8 km on average and the inner ring has almost exactly half the diameter of the outer wall. A part of the craters is located on flat intrusive bulges (eg Marth).

Are they a combination of normal impact crater (outer wall) and following lunar volcanism (inner wall)? Perhaps a normal impact on an intrusive bulge (dome) followed by an annular extrusion of very high viscous lava, which formed the inner wall?

Dark Halo craters: DH craters look very similar to calderas with pyroclastic deposits, but should not be confused with them. Unlike the lunar domes with their calderas, the DH craters are normal impact craters, where dark (already cooled) mantle material was brought to the surface. Dark Halo craters are most clearly visible under full moon conditions.

Prominent examples of Dark Halo craters are Beaumont L in Mare Nectaris and Copernicus H just south of the large crater Copernicus.

Elongated impact crater: Experiments with specially developed highspeed guns from NASA in the 60- and 70ies of the last century showed that very fast projectiles always produce round impact craters if the impact angle is larger than 5 degrees. Just at angles well below 5 degrees and up to grazing impacts elliptical impact structures were formed. The most striking elliptic crater is Schiller near the southwestern edge of the moon.

Polygonal (pentagonal) crater forms: The origin is also unexplained. These craters are not as rare as you might think. Prominent examples are Proclus, Kepler, Encke and Callippus. Even the crater Copernicus is not circular, it appears octagonal.

Secondary craters: were created from back-falling ejecta of the primary impact. They often have a "herringbone" appearance, clearly observable in the secondary crater of Copernicus and Theophilus.

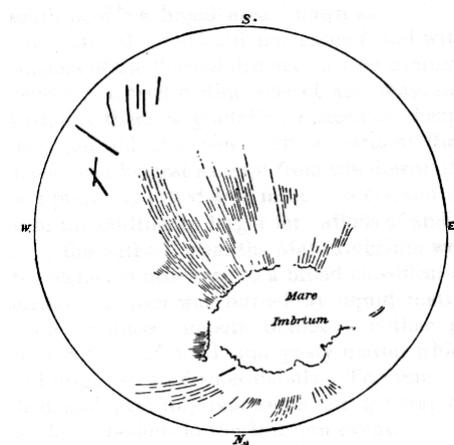
More brief notes on the crater descriptions:

LRO = abbreviation for the Lunar Reconnaissance Orbiter, current (2016) lunar orbiter from NASA¹

Weathering = Not to be confused with weathering as on Earth. The two main triggers for weathering on the moon are the fast particles of the solar wind and the impact of micrometeorites over billions of years.

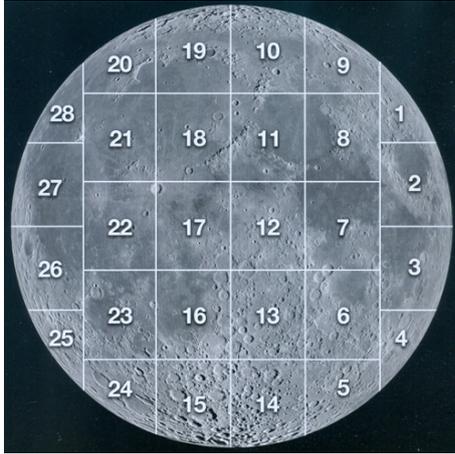
stratigraphy = is (on either Earth or moon) a method to create a temporally graded relative time scale for the formation of a region based on morphological observation of the landscape. A striking example is described using the craters Helicon and Le Verrier in the northern part of Mare Imbrium.

Imbrium Sculpture = is a term introduced by US geologist Karl Gilbert. Gilbert was the first lunar observer who noticed that many "streaky" structures (valleys, rilles in the crater walls, etc.), especially in the area of the large craters Ptolemy, Alphonsus and south of Albategnius, are radially orientated to the center of the Imbrium basin.



In his book "The Moon's face, a study of the origin of its features", he published his famous sketch (shown at left) of the Imbrium Sculpture in 1893.

¹ <http://lunar.gsfc.nasa.gov/>



The following crater list is ordered according to the book by Charles A. Wood and Maurice Collins: 21st Century Atlas of the Moon, 2012.

The description starts in the northeast of the moon with segment 1 and ends with segment 28 in the northwest of the moon.

1

Cleomedes is a crater north of Mare Crisium with a diameter of 130 km. His narrow system of rilles is difficult to observe because of the distortion at the lunar edge. On the crater floor are some small Dark Halo craters. The crater Tralles (43km) lies on the northwestern crater rim. Its impact produced major boulders on the floor of Cleomedes.

Geminus is with a diameter of 83 km a classic complex crater with terraced crater walls and remainings of central mountains on the crater floor. Looking at it on the LRO images vertically from above, it looks like a smaller version of Tycho. However, it is much older, because it shows no ray system. The most likely formerly existing ray system was darkened over billions of years due to the solar wind.

Messala is with a diameter of 122km, a large but very old and weathered crater. The crater floor is covered with ejected material of the Humboldt Basin, thus it is older and formed before the Humboldt impact.

2

Mare Crisium (620 x 570 km) is the only Mare, which has no contact with any of the other Mare. Looking at it on LRO images vertically from above one recognizes that it is not round but elliptically shaped. It is created either by an impact at a very flat angle or by two separate impacts. Interesting craters in the basin: Lick, a "Floor Fractured crater" with clearly bulged floor and Picard, which shows a strange double structure (crater in the crater).

Proclus (27 km in diameter) has a distinctly polygonal shape and a distinctive asymmetric ray system. It originated from an impact with very shallow impact angle, the projectile came from an easterly direction.

Taruntius comprises 57 km in diameter and is a typical "Floor Fractured crater". It shows concentric ridges, a system of rilles and two dark pyroclastic deposits on the crater floor.

3

Crozier H is with a diameter of 11 kilometers, the second largest concentric double crater on the front of the moon. The largest is Hesiodus A which lies on the edge of the Mare Nubium.

Messier (14 km) and **Messier A** (11 km) are probably the most bizarre crater pair on the moon. Messier was created by a grazing impact from the east, Messier A by a

"rebound". The two comet-like beams are also spectacular. When the sun is rising, two further rays become visible which run perpendicular into the northern and southern direction. The entire beam system - with a little imagination – has the appearance of a butterfly. Overall, the ray system is similar to all other systems which are created by a shallow impact such as the ray system of Proclus.

Petavius B (32 km) was also created by an impact at a very flat impact angle. The projectile came from the north east. The ray system is bright and striking and also resembles that of Proclus.

Rima Goclenius is a 190 km long fault zone, which probably originated when the center of Fecunditatis basin slowly sank under the weight of the lava.

4

Petavius (170 km) and **Humboldt** (200 km) are both "Floor Fractured craters". **Humboldt** is very difficult to observe because of its extreme location at the lunar edge and requires favourable libration conditions. On the crater floor are large areas of pyroclastic deposits and it has large central mountains.

The system of rilles on the crater floor of **Petavius** is spectacular. Small pyroclastic deposits (in the north) and a small effusive lunar dome (south) are on the crater floor.

Furnerius (135 km) is smaller and significantly older than Petavius. On the crater floor there is a long linear rille.

Stevinus A (10 km) and **Furnerius B** (10 km) are two craters of the same size, which, for this crater size, both have an extremely bright ray system, implying that they are very young.

5

Janssen is with a diameter of 200 kilometers a superposition of craters, because it is not round but elliptically shaped. The southern crater floor is smooth, the northern floor is covered with ejecta of Fabricius. Both areas are divided by the spectacular, slightly curved Janssen rille. Such a rille is rare in the highlands and therefore noteworthy to be addressed.

Fabricius (80 km) differs in its appearance from the normal standard crater model, because it has two central mountain massives, one of them far from the middle of the crater.

Vallis Rheita is with a length of over 500 km, the largest secondary crater chain on the near side of the moon and not a valley such as the Vallis Alpes. The chain is aligned radially to the center of the Nectaris basin and was apparently created by the Nectaris impact. At the crater Mallet (56km) the Vallis Rheita shows a slight change in direction. They might be two different rows of secondary craters.

Boussingault (128km) is close to the south pole of the moon. For its observation a favourable libration is needed. It is a double crater, the second crater, half the size of Boussingault, is located eccentric to the middle.

6

Rupes Neander is with 77 kilometers length a little observed fault in the highlands of the moon and extremely rare. Like many of these slopes, the structure continues into a rille at its end (here in the south). Other examples are Rupes Cauchy and Rupes Lacus Mortis.

Fracastorius (130 km) is a complex crater which is strongly tilted to the center of the Nectaris basin. The northern crater rim and the crater floor are completely flooded by the lava of the Nectaris basin. After the lava cooled off and the Nectaris lava shield further subsided a thin fracture zone formed which crossed Fracastorius. The smaller crater Beaumont is also tilted towards the Nectaris basin but doesn't show any fracture zones.

Rupes Altai is with a length of 550 kilometers part of the crater walls of the Nectaris basin impact (similar to the Apennines). The Wall reaches a height of 3 to 4 km above the surrounding highlands and reaches impressive 7 km above the center of the Nectaris basin.

Daguerre (45 km) is an almost entirely lava flooded crater with strange concentric ridge remnants and dark pyroclastic ash deposits. Maybe Daguerre and the complete region is of volcanic origin.

7

Rima and Rupes Cauchy - The region around the 12.5 km wide crater Cauchy is rich in lunar domes and other structures of lunar volcanism. **Rupes Cauchy** is a 170-km long slope with a height of 340 meters which merges into a rille at its end. Southerly are the two major lunar domes Cauchy Tau and Omega. Many of the lunar domes as well as Rupes and Rima Cauchy are radially aligned to the center of the Imbrium basin - coincidence?

Lamont is about 80 kilometers across and a unique lunar structure. Possible a completely flooded impact basin with a double wall ("Two ring basin"), indicated by concentric ridges. In any case, Lamont is the center of a so-called **MASCON**, a mass concentration that changes the local gravitational field. Next to the crater **Arago** (26 km) are two large complex lunar domes: Arago Alpha and Arago Beta, which are easy to observe when the Terminator is close by.

Sabine (30 km) and **Ritter** (30 km) show both an annular inner hill structure. For a long time this was interpreted as a volcanic origin but today the craters are assigned to the "Floor Fractured craters".

Theophilus (100 km) is a magnificent and complex crater which is relatively young, it has a very distinct central mountain. Its crater rim rises 4.5 km above the crater floor. Easy to observe are smooth, partially melted ejecta on the crater floor and in the northern surrounding of the crater. In the area towards the crater **Torrighelli** secondary craters are visible.

8

Gardner Megadome is a 70 km large, elevated area, south of the crater Gardner (18 km). The plateau is interpreted as a huge shield volcano with a huge caldera.

Jansen (23 km) is almost completely flooded with lava. The many nearby lunar domes and the sinusoidal rille **Rima Jansen** suggest that the whole area is of volcanic origin.

Plinius (43 km) is a very young crater complex with terraced walls and central mountains. Ejecta and secondary craters on the mare surfaces clearly show that Plinius is much younger than the surrounding lava fields of the Serenitatis- and Tranquillitatis basin.

9

Endymion, 122 km in diameter, is a Plato-like crater with smooth lava on the crater floor. **Atlas** (87 km) and **Herkules** (71 km) – are a crater pair of nearly the same size, but with completely different crater floors. Atlas is a "Floor Fractured crater" with a system of rilles and pyroclastic ash deposits. Hercules shows a young, smooth crater floor, flooded with mare lava.

Franklin (56 km) and **Cepheus** (40 km) are a smaller versions of the crater pair Atlas and Hercules. Franklin a "Floor Fractured crater" with bulged floor and system of rilles, Cepheus with a lava flooded crater floor.

10

Cassini (56 km) is a strange crater, deviating from the standard profile of complex craters of this size, surrounded by a thick ring of ridges. Inside are two larger craters and a strange, "crushed" ridge between the western crater wall and the larger central crater on the crater floor.

The Vallis Alpes is a long land subsidence of 155 km length that divides the impact wall of the Imbrium basin into the Apennines and the lunar Alps. The base of the land subsidence is filled with lava that comes from a narrow, sinuous rille in the middle of the Vallis Alpes. The rille is only 700 to 1,000 of meters wide.

11

Linne is a crater with a diameter of just 2 km, which is surrounded by a small ring of very bright ejecta - but with a very interesting history. In 1866, quite legitimate lunar observers reported that the crater had disappeared. Then it was spotted again and disappeared again. Linne is a young, normal impact crater and was of course never invisible. The observers were simply mistaken.

Rima Sulpicius Gallus is a 80 kilometer long fracture zone, surrounded by pyroclastic ash deposits, created as the Serenitatis pool slowly lowered under the heavy weight of the large amount of lava.

Rima Hadley is the prime example of a sinusoidal rille - a former lava channel - with a total length of about 116 kilometers. The former caldera of the channel (which is now collapsed) has a diameter of about 7 km and is located at the southeasterly beginning of the rille. The official name is JOMO. Rima Hadley was the landing place of Apollo 15.

Valentine Dome (30 km) is a volcanic intrusion with a height of only 80 meters. Approximately in the middle of the plateau there is a small mountain slope, which merges into a rille and has its origin in the Serenitatis lava.

12

Descartes (28 km) is a highland region and was the landing site of Apollo 16. It is a very hilly area and even for upland regions of the moon it is an unusual structure. NASA expected to find rock samples of volcanic origin in this area but most of the material which was brought to the ground were "normal" ejection rocks.

Hyginus (11 km) is a "crater" without crater wall and is thought to be one of the few volcanic calderas on the front of the moon. It is centrally located between two rilles – together 200 kilometers long – which are probably also of volcanic origin. A highlight for every lunar observer.

Triesnecker (26 km) is located in the vicinity of an intersecting rilles system which has a total length of approximately 200 km and extends into the northern part of the **Hyginus** region. Triesnecker and his system of rilles is also a highlight for lunar observers.

Dionysius is with a diameter of 18 kilometers a crater with an exceptional and unique ray system. It is surrounded by a ring of light material and dark rays, the material of the rays comes from deeper layers of the Mare lava. The ray system can be best observed under a high solar illumination.

13

Abulfeda (62 km) is a normal impact crater. Interesting is the crater chain **Catena Abulfeda** of approximately 210 kilometer length which is tangential to the southern crater wall. Most crater chains can be assigned to a big impact (eg Vallis Rheita), this does not apply to the Catena Abulfeda. In both directions there are no big impacts. Most likely the crater chain can be traced back to the broken nucleus of a comet. This is similar to the comet Shoemaker-Levy, whose fragments crashed into the atmosphere of Jupiter during the summer of 1994.

Pontanus E is, with a diameter of 13 km, one of the few double concentric craters of the front side of the moon. It is an exception, since all the other double craters are close to the border regions of a large Mare. Pontanus E lies in the highlands, where some lunar scientists suspect a completely "bombed" and ancient basin named Werner - Airy. Pontanus E must be very old, because it is badly weathered.

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Boussingault (128km) is close to the south pole of the moon. For its observation a favourable libration is needed. It is a double crater, the second crater, half the size of Boussingault, is located eccentric to the middle.

Heraclitus (85 km) is located just south of the crater Stöffler. It is an unusual, long and stretched formation. Either it is a superposition of several impacts or the region arose from an impact with extremely shallow impact angle. A similar crater is Schiller in the southwestern area of the moon.

Miller (61 km), **Nasireding** (50 km) and **Huggins** (66 km) are three medium sized craters. The impact of Nasireding happened last, as indicated by the landslides in Huggins and Miller.

15

Drygalski (162 km) is a large crater near the south pole of the moon and has a similar structure as Copernicus even though it is much larger and older. Its observation requires favourable libration conditions and even in this case then Drygalski is only visible as a profile due to its location near the lunar edge.

Tycho, with its diameter of 86 kilometers, is the prototype of a complex crater with a terraced wall system and complex central mountains. The crater floor lies 4.7 km below the crater walls. Observing Tycho under high illumination (full moon), a ring of molten impact material can be clearly recognized. **Tycho** is probably one of the youngest craters (100 million years) and has the biggest and brightest ray system of all lunar craters. The ray system is asymmetrical and almost absent in the western region. This points to an impact with a very flat angle from this direction.

Moretus (114 km) is a Tycho like crater but significantly older. Because of its location at the lunar edge it appears highly distorted. It has impressive central mountains where, when looking at photographs made through large telescopes, different stratifications can be distinguished.

Newton (75 km) consists of four, partly overlapping, craters (Newton A, G, N and D). **Newton D** has with roughly 7 kilometers one of the largest height differences between crater wall and crater floor. Best observed under favorable libration conditions.

16

Alpetragius (40 km) is a normal impact crater, but with an extraordinary Central Mountain, which occupies almost 1/3 of the crater floor. This probably shows volcanic activity of very slow-moving lava after the impact. Throughout the region east of **Alphonsus** and **Arzachel** are some similar craters with unusual central mountains.

Alphonsus, 111 kilometers in diameter, is a distinctive but narrow system of rilles surrounded by some micro volcanoes and pyroclastic ash deposits caused by effusive volcanism. The hillside, which crosses the crater diagonally, consists of ejecta from the Imbrium impact and thus Alphonsus must be older than the Imbrium basin. The whole region shows the marks of the Imbrium impact. These marks are together referred to as the "**Imbrium Sculpture**".

Hesiodus A (14 km) is the largest and most easily observable concentric double crater on the near side of the moon.

Pitatus (100 km) is a prime example of a "Floor Fractured crater" with a bulged crater which is flooded with very dark lava.

Rupes Recta and **Rima Birt** are both located in an ancient crater (200 km) of which only remnants of the eastern walls are recognizable. The western wall is only indicated by curved ridges. **Rupes Recta** (long wall) is a 400 meter high mountain slope, but it has relatively flat flank angles. The eastern part next to **Rupes Recta** must be much older than the western region, this is clearly visible because the crater density is significantly higher in the eastern region.

West of **Rupes Recta** is the rille **Rima Birt**, which in the northern part is associated with two lunar domes, which are divided by the rille. Presumably, the rille is a vertical-volcanic fissure.

Both **Rupes Recta** and the **Rima Birt** point radially towards the center of the Imbrium basin and probably have their origin in the Imbrium impact.

17

Copernicus H is a prominent Dark Halo crater with a size of 4 km. It is not active volcanism but a normal impact crater, by which dark mare basalt was ejected to the surface.

Catena Davy is a crater chain of 50 km length. It consists of more than a dozen small craters, where the largest has a diameter of roughly three kilometers. For a long time it was suspected that the craters have volcanic origin. Today the craters are seen as normal impact craters, caused by a desintegrated nucleus of a comet like Shoemaker-Levy (1994), similar to the crater chain **Catena Abulfeda**.

Fra Mauro (100 km) is an ancient crater that was filled with ejecta of the Imbrium impact (landing site of Apollo 14 north of **Fra Mauro**). From the rocks samples which were brought back to Earth, the age of the Imbrium impact was quite accurately determined to 3.85 billion years ago.

Gambart (25 km) and **Mösting** (25 km) are two craters with the same size and with almost identical crater walls. The crater floors, however, differ vastly. While **Mösting** is a classic complex crater with landslides and a small central mountain the crater floor of **Gambart** is flooded with lava.

Did **Gambart** earlier on look similar to **Mösting** and only later was flooded with mare lava or do have both craters different origins? More craters like **Gambart** are for example **Tobias Mayer** and **Kunowsky**.

18

Archimedes (81 km) is another highlight of lunar observation and probably looked very similar to **Copernicus** at the beginning. The outermost ejecta was later covered by the Imbrium lava flows. The crater floor was flooded by lava which come through fissures and covered the terraced walls and central mountains.

Between the **Archimedes Mountains** (just south of **Archimedes**) and the **Apennines** is a region that is called the "**Apennine bench**". It is a region which probably shows the original crater floor of the Imbrium basin, which was high enough to be not covered by the lava flows.

Bode pyroclastics - In the northeastern part of **Sinus Aestum** are the so called Bode pyroclastics, one of the largest eruptive ash deposits of the moon. Its origin was the "fire-breathing" volcanism from the nameless rille nearby.

19

Plato is, with a diameter of 101 kilometers, a Archimedes type crater, flooded with extremely dark Mare lava. In the western part there is a large, triangular landslide. At sunrise the eastern crater wall casts spectacular shadows on the lava field in the interior of the crater.

Rimae Plato is an approximately 180-kilometer long, complex sinusoidal system of rilles and therefore of volcanic origin. The largest of the rilles is located northeast of Plato.

Helicon (24 km) and **Le Verrier** (21 km) are the only larger craters in the northern region of the Imbrium region. At first glance they are very similar and are one of the best examples of the lunar stratigraphy. When observing the two craters near the terminator (sunrise) impact ejecta can be seen outside Le Verrier but it is completely lacking in Helicon. It can therefore be deduced that Helicon is significantly older than Le Verrier. The ejected material from Helicon was covered by the Imbrium lava and the impact of Le Verrier took place after the lava flows of the Imbrium impact ended.

20

Mairan T is with a size of only 7 x 9 km a very small and rarely observed lunar formation. It is a small lunar dome with steep flank angles which was built from very viscous lava. At the top is an irregularly shaped caldera. Nearby are several, very narrow, sinusoidal rilles, the largest of them is Rima Mairan. Near the terminator Mairan T casts a distinctive shadow over the lava field.

Sinus Iridum (250 km) - the Bay of Rainbows. A lunar highlight at sunrise. The bay looks like a safe harbor with a few shallow waves (ridges) rolling toward it from the Sea of Rains (Mare Imbrium).

Sinus Iridium is one of the largest lunar craters (maybe a small basin), which is inclined to the center of the Imbrium basin. Its entire southern and eastern wall were flooded by the Imbrium lava. The two capes, Heraclides in the western area and Laplace in the eastern region, show significant height differences. Cape Laplace is significantly higher than Cape Heraclides.

Mons Rümker is, with a diameter of 75 kilometers, one of the largest intrusive volcanic structures on the front of the moon. Half a dozen other effusive lunar domes are scattered on its surface. It is a completely unique structure.

Mons Rümker is difficult to observe due to its location next to the lunar edge so favorable libration conditions are necessary. In the era before Apollo, Mons Rümker has been classified as a largely destroyed large crater.

Pythagoras measures 145 kilometers in diameter and is similar to the Copernicus crater. Due to its location close to the North Pole it only can be observed in profile (ensure favorable libration). The irregular distribution of the ejecta indicates an impact with a shallow angle from the northwest.

21

The Gruithuisen Domes (Gamma and Delta, 20 and 27 km) are two of the largest and therefore easily observable lunar Domes. They were built by very slow-moving lava and have relatively steep flanks, similar to Mairan T or Liebig 1. They are probably a mixture of intrusive and effusive lunar volcanism.

Krieger (23 km diameter) is a crater with a lava flooded floor. Due to a gap in the western crater wall two steep shadows are cast at sunrise, with a little imagination one can see the shape of a rabbit with its two ears.

Montes Harbinger (95 km) and the **Rimae Prince** - Prince (47 km) is a crater which is almost entirely flooded with lava crater and whose southwestern wall is completely absent. A number of hills and several sinusoidal rilles indicate that a land uplift and strong lunar volcanism - similar to the of Aristarchus plateau – were responsible for the origin of this region.

Mons La Hire is a peak with a size of 20 x 10 km. The lava shield of Mare Imbrium consists of hundreds of thousands of temporally successive lava flows which are indistinguishable from Earth if using amateur equipment.

Starting north of the crater **Euler** there are some flat lava layers which can be distinguished from each other at sunrise. They continue in a northeasterly direction, passing Mons La Hire and cross the ridge **Dorsa circle**. Even in the eastern part of the Mare Frigoris (near Atlas, Hercules and Lacus Mortis) individual lava flows can be distinguished.

22

Copernicus measures roughly 100 kilometers in diameter and is the prototype of a very young, complex crater. He has clearly terraced crater walls and the central mountains are divided into two parts. The crater floor is partially smooth and flat (covered with molten ejecta), on the opposite side there is a hilly region. The crater floor is 3.8 kilometers beneath the crater walls which rises less than 1 km above the surrounding landscape. The longest rays of the young ray system can be tracked up to a distance of 800 km. In the immediate vicinity hundreds of secondary craters can be observed.

The Hortensius Domes are a classic small-scale lunar field of 7 lunar effusive shield volcanoes with diameters of 10 to 15 kilometers and small summit calderas. In this region between Kepler in the west and Copernicus in the east are around 2 dozen other domes, e.g. west of Milichius the great Dome Milichius Phi.

Kepler (29 km) and **Encke** (28 km) are two almost equally sized craters with a polygonal form. Contrary the crater floors and their depths are very different from each other. Encke is a typical "Floor Fractured crater" with a depth of "only" 700 meter, Kepler shows a standard crater floor with a central peak and a depth of 2.7 kilometers. Kepler is a very young crater with a distinctive ray system while Encke has lost its ray system by erosion (solar wind) and therefore it must be much older than Kepler.

23

Gassendi (110 km) is a classic "Floor Fractured crater", which has a clear incline towards the center of the Humorum basin. The crater floor is covered with narrow intersecting rilles and a large central mountain. The tilting towards Mare Humorum is clearly visible, the northern crater wall is high, the wall next to the basin is considerably lower. On the northern edge of the Humorum Basin lie the craters **Doppelmayr** and **Lee** which are similarly tilted to the basin. Before fundamental changes happened, Gassendi presumably looked very similar to Copernicus. Northeast of Gassendi begins a long and extremely narrow sinusoidal rille, the **Rima Herigonius**.

Kies Phi (15km) is a relatively large effusive lunar shield volcano (Dome) with summit caldera of 2 km width. Because of its large diameter it is relatively easy to observe when near the terminator. The crater **Kies** (44km) lying to the east and is almost completely flooded with lava. The crater **Capuanus** is located quite a bit south of Kies and on its crater floor are three further small lunar domes. They are an exception because lunar Domes are extremely rare within craters.

The Agatharchides Plateau (60 x 45km) is classified as an intrusive lunar Mega Plateau, similar to the Gardner Mega Plateau. The composition of the rocks is similar to the Gruithuisen domes and the mountain Mons Hansteen. On the eastern edge of the plateau is an extremely narrow - unnamed - rille.

Unofficially this structure is named "**The Helmet**" because its shape is reminiscent of the helmets of the famous Star Wars movies.

Rima Doppelmayr is a 130 km long, narrow and linear rille and maybe the origin of the dark pyroclastic ash deposit nearby. In the northern region the rille branched into several segments. In the southeast is a steep lunar dome called **Liebig 1** is located, which is similar to the Dome **Mairan T** .

Rimae Hippalus are large fracture zones with a total length of 240 km. They originated from the subsidence of the lava shield of the Humorum basin. The maximum width of the rilles is about 4 kilometers.

In the Humorum region are many further system of rilles such as **Rima Hesiodus**, **Rimae Agatharchides**, **Rimae Ramsden**, **Rimae Palmieri**, **Rimae de Gasparis** and **Rimae Mersenius**.

24

Bailly, with a diameter of nearly 300 kilometers, is one of the largest craters on the front side of the moon. But due to its location at the edge it is only visible under very favourable libration.

Schiller is one of the most bizarre lunar craters. It is 180 km long but only 75 km wide. Its very unusual shape suggests a grazing impact. The formation Schiller is unique on the front of the moon.

Heinzel (68 x 19km) has, due to its shape, the nickname "Peanut crater". It is the result of a superposition of 3 impacts over a total length of nearly 70 km.

Wargentín (87km) is as unique as Schiller. It is the only crater which is flooded with lava up to the crater wall and even beyond. On the surface y-shaped ridges are visible. In the northeast, the lava flowed over the crater wall and formed the smooth lava region east of Schickard.

25

De Gasparis is a crater with a 30 km diameter, which is located directly on the western edge of Mare Humorum. In the center of the crater two rille systems - **De Gasparis** and **Palmieri** - intersect with each other. Coming from the north **Rima Mersenius** is ending. Similar intersections of rilles can be also observed in the crater Palmieri.

26

Mersenius, which measures 84 kilometers in diameter, is a very impressive "Floor Fractured crater" with a lifted crater floor and a system of rilles. The two large rilles, **Rima Mersenius** and **Rima Sirsalis** point radially to the large Oceanus Procellarum.

Hansteen (45km), **Mons Hansteen** (31km) and **Billy** (46km). Hansteen and Billy are of approximately the same size but different in structure. Billy has a crater floor flooded with very dark lava while Hansteen is probably a "Floor Fractured crater". It is also located very close to the edge of Mare Procellarum.

Mons Hansteen is like the **Agatharchides Plateau** an intrusive, volcanic land uplift. The rock material of Mons Hansteen contains much more silicon than the lava around and comes from a greater depth.

27

Marius Hills is the largest lunar dome field. Covering an area with about 230 kilometers in diameter, it contains roughly 300 precipitous volcanic domes, which are crossed by several sinusoidal rilles. The longest rille - with a total length of 250 km - is the **Rima Marius**. It begins north of the crater **Marius** (41km) with a width of only 2 km and gets gradually more narrow. A minor rille, the **Rima Galileo** - lies west of the crater Marius. The Marius Hills are a unique lunar formation.

Reiner Gamma is also one of the most extraordinary structures - and one of the most mysterious. It is an oval, bright area with a "tail" of over 200 kilometers. No incline and no subsidence the height difference is roughly 0 meters. Reiner Gamma is a lunar **SWIRL**, a region with a strong magnetic anomaly. It is the only SWIRL on the front side of the moon. The total length of the structure is about 240 km.

Presumably the relatively strong magnetic field - compared to the rest of the moon – prevents a darkening of the material by the solar wind. But which event generates a magnetic field anomaly of this kind? Reiner Gamma is easy to observe at a high Sun elevation but the origin of Reiner Gamma is not at all understood.

28

The Aristarch plateau, with a size of roughly 170 x 200 kilometers, is diamond-shaped structure and one of the most extraordinary lunar regions. It is a raised structure, sometimes with a height of up to 1.5 kilometers above the surrounding lava of Oceanus Procellarum. It lies there like an island. The plateau is clearly of volcanic origin, the entire surface is covered with a 30 to 50 centimeter high layer of pyroclastic ash. To this day

the origin of the Aristarchus Plateau is poorly understood and lost in the mists of lunar history.

Aristarchus is 40 kilometers in diameter. It is the brightest and one of the youngest craters of the lunar front with an estimated age of "only" 175 million years. It is surrounded by a very asymmetric and extremely bright ray system and the crater walls show a pronounced streaky structure between light and dark material.

Vallis Schröteri has a total length of 185 km and a width of 3 to 6 km. It is the largest sinusoidal lava channel of the moon. On the floor there is in additionally an extremely narrow rille.

The Origin of the lava flow is a great (collapsed) Caldera with the unofficial name "cobra head", situated north of Aristarchus and Herodotus.

Montes Agricola (160km) is also a unique structure. It is a drawn-out ridge and certainly not a residue of a basin or crater wall. The surface is structured differently than the **Aristarchus Plateau** and therefore most likely not just a separated part of the plateau. His origin is also lost in the dark of the lunar history.

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