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A NEW CLASSIFICATION OF EOLOGLYPTOLITHS

The term *eologlyptolith* (derived from the Greek: Eol — Aeolus, god of winds, glyptos — rounded, litos — stone, pebble), introduced by J. Dylik (1952) into the geologic nomenclature, refers to rock fragments bearing well-marked traces of eolization, i.e. smoothing and polishing work of mineral particles blown by the wind. Wind action is most intensive in the present-day arid and semi-arid regions, and was likewise vigorous in the Pleistocene periglacial zone. This action gives rise to the formation of: (1) smoothed rock-fragment surfaces which become so lustrous that they take on a varnished appearance (the so-called desert varnish), (2) peculiar miniature cavities or honeycomb structures, pits and other near-rounded miniature holes in the eolized stone surface (etched and/or honeycomb structures), sometimes narrow and twisted grooves appearing on the stone face, etc.; (3) facetted stones i.e. rock fragments having one or more smoothed and polished facets separated by reasonably well-defined edges.

Some years ago the present writer proposed the term *vetrogrannik* (= wind facetted stone) as synonymous with the German *Dreikanter, pyramidal Gerölle* and others. This term, however, does not cover all the varieties of eologlyptoliths, and is particularly misleading in the case of forms showing no distinct facets and edges, of irregular either conical (cone-like eologlyptoliths) or cylindrical (tube-like eologlyptoliths), and ball-like (spheroidal eologlyptoliths, called by I. Walter „stone rain") forms.

Dylik's term *eologlyptolith* is therefore more comprehensive than the present writer's term *vetrogrannik* (= wind facetted stone) and should be used to designate all rock fragments bearing traces of eolization, irrespective of the presence of facets and edges in the stone surface.

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In the classification of eologlyptoliths, morphologic and structural characteristics ought to be taken into account as well as the rock of which they are derived, their varnish-surface coating, etc.

As regards their morphology eologlyptoliths fall into two main varieties: (1) the facetted one including forms which show distinct facets and edges (facetted stones proper), and (2) the non-facetted one, consisting of forms which lack both these elements.

Depending on the number of facets the first variety may be divided into the following groups: (1) one-facetted, (2) two-facetted, (3) three-facetted, and (4) multi-facetted stones.

One more or less flat facet is characteristic of one-facetted stones (Fig. 1: 1, 2); in most cases the facet is but slightly marked on the other side of the stone. The eologlyptoliths belonging to this group are generally modelled from plate and thin quartz, flint or other rock fragments hardly projecting above the ground surface. Provided they do not change their initial position such stones have only their upper flat surface smoothed and polished by wind-blown sand and dust particles. The lower, basal surface of such eologlyptoliths lacks traces of wind action, it is rough with frequent protrusions and primary cavities. Depending on the initial shape of a rock fragment, the one-facetted stones may be isometrical, oval, cone-like, shapeless, etc. Such eologlyptoliths however are rather rare, for the original eolized rock fragments are generally rather thick and their surfaces are subjected to facetting and edging.

Two-facetted stones and ridge-like eologlyptoliths (Fig. 1: 3—6) are much more common than one-facetted ones. They differ from the latter in that they have one long-edge running through the highest surface points (ridge) of an eologlyptolith. This edge separates two facets inclined in opposite directions. The cross-profile of two-facetted stones is obtuse, angle- or saddle roff-like. The long-edge may be clear-cut and sharp or rounded and flat; in the latter case two-facetted stones show a broad-parabolic cross-profile. Moreover, the long-edge may be rectilinear or bent according to the inclined facet surfaces. If the facets are low (narrow) two--facetted stones tend to assume a sickle-like shape (Fig. 1: 5). Sometimes the long edges are bent to form an S-like shape (Fig. 1: 6); if well-formed facets repeat the S-like edge bend, the whole stone also takes an S-like shape.

If a rectilinear edge separates two facets of nearly unisosceles triangular forms the facetted stone shows a lancet-like shape (Fig. 1: 4); the spike of such a lancet-facetted stone *in situ* is, as

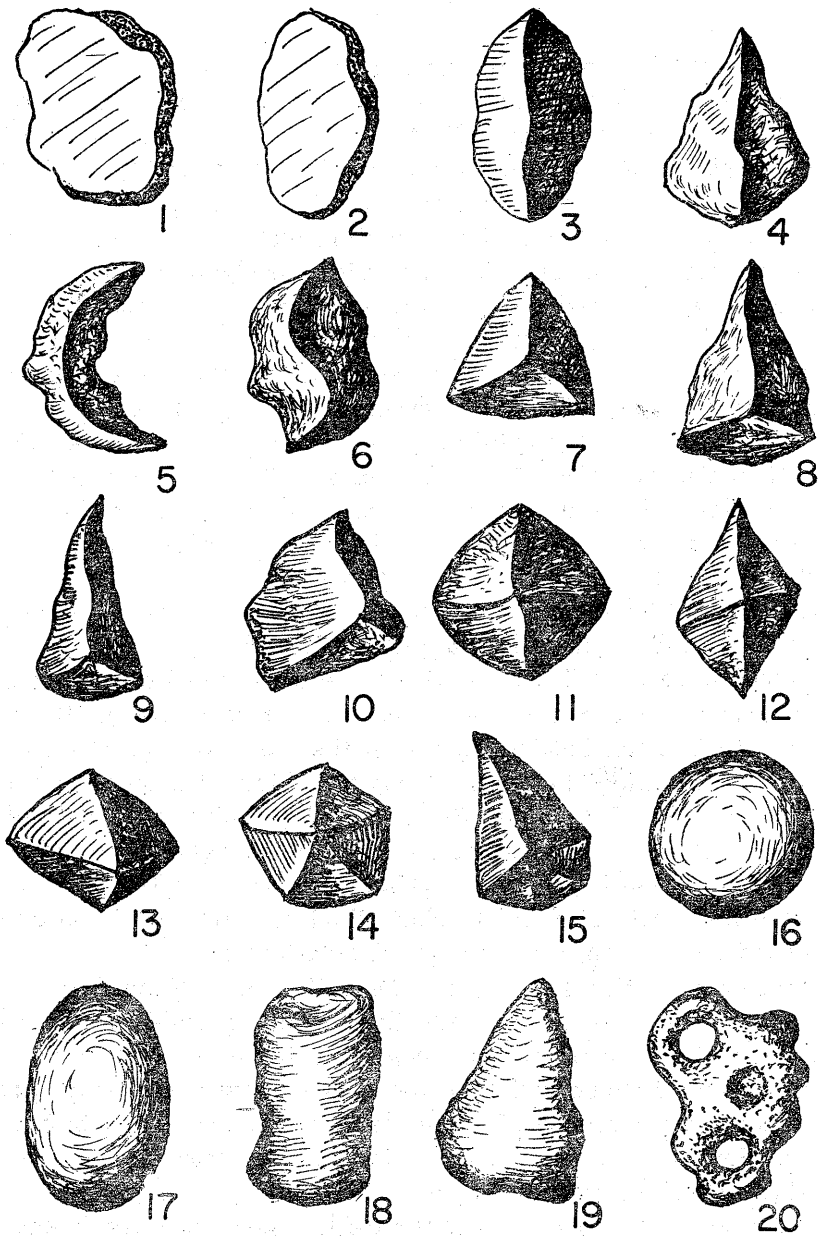

Fig. 1. Main forms of eologlyptoliths

1—15 — facetted eologlyptoliths, or facetted stones proper:

1. isometrical one-facetted stone; 2. elongate one-facetted stone; 3. oval (ridge roof-like) two-facetted stone; 4. lancet-like two-facetted stone; 5. sickle-like two-facetted stone; 6. irregular two-facetted stone; 7. isometrical three-facetted stone; 8. lancet-like three-facetted stone; 9. wedge-like three-facetted stone; 10. irregular three-facetted stone; 11. isometrical four-facetted stone; 12. rhomboidal four-facetted stone; 13. irregular four-facetted stone; 14. isometrical multi-facetted stone; 15. irregular multi-facetted stone

16—20 — non-facetted eologlyptoliths: 16. spheroidal („stone rain"); 17. ellipsoidal; 18. cylindrical (tube-like); 19. conical; 20. irregular

a rule, directed in the prevailing wind direction either at the present-day or in the past. Therefore, such facetted stones may be regarded as „geologic wind-direction indicators". In the plane irregular two--facetted stones are mostly elongate ellipsoids (Fig. 1: 3); if the stones are *in situ* their basal surface is unfacetted by wind and the edge is oriented parallel to the prevailing winds.

Three-facetted stones, i.e. „classic" *Dreikanters* proper, are commonly encountered in the form of pyramidal eologlyptoliths which testify to intensive wind action to-day as well as in the geologic past. The junction of three edges at the upper tip of a triangular pyramid, is characteristic of these facetted stones. Accordingly such eologlyptoliths have three, more or less wind--smoothed facets. Most facetted stones belonging to this group have one long clear-cut and rectilinear edge oriented in the wind direction and two shorter, usually less carved edges on the leeward sides. The two head-facets (against the wind) are commonly narrow and elongate, well sculptured, but the leeside facet of an isosceles triangle form is but slightly smoothed.

Isometric forms (Fig. 1: 7) with more or less uniform sides are rarely encountered among these facetted stones. However, the pyramid's tip is often located nearer to the leeward side of a facetted stone: thus the eologlyptolith has the shape of a lance or unisosceles triangle (Fig. 1: 8). Such eologlyptoliths may be called lancet-like three-facetted stones. Often, the eologlyptolith ridge is cut off; as a result the pyramid top disappears and a horizontal triangle-like facet arises in its place. Such a new facet is bordered on all sides by steep, almost vertical side-facets.

Further eolization leads to the formation of very narrow facetted stones whose length exceeds their width several times: such eologlyptoliths may be called wedge-like three-facetted stones on account of their shape which is that of a narrow wedge (Fig. 1 : 9). The frequent occurrence of these forms is important as they provide evidence of far-advanced wind-caused erosion and of the long-lasting eolian carving of rock fragments.

Although in the plane some three-facetted stones are irregular in outline (Fig. 1: 10), they retain the main characteristics of the eologlyptoliths of this group: convex and projecting upper stone part with three facets and three edges converging at the top.

Four-facetted stones are rarer. They exhibit four more or less well-defined triangular facets and four edges, both falling radially downward. Depending on their basal contours they may be divided

into: isometric forms — with a tetragonal base (Fig. 1: 11), rhomboidal one — with an elongate or rhomb-like base (Fig. 1: 12), and irregular ones with an asymmetrically located top-point, shifted backward to the leeside of the eologlyptolith (Fig. 1: 13). If they occur *in situ* such facetted stones may be also regarded as „geologic indicators of wind-directions" for in that situation they are always directed with the acute end against the prevailing winds.

Elongated multi-facetted stones (Fig. 1: 15) are similar to those described above. They have more than four of both facets and edges. If such facetted stones are *in situ*, their longer and sharpened ends indicate the prevailing wind directions. Isometric forms showing irregular, penta- or hexagonal basal outlines are rare among this group. For the most part, their edges are smoothed and feebly marked, and the top point is blunt.

A characteristic feature of all dome-like and pyramidal facetted stones is their bottom surface which is, as a rule, uneven and shows no traces of eolization. These testify to the unchanged position of the eologlyptolith from the beginning of wind action upon the stone. If the facetted stones are overturned, their whole surface underwent eolization which tended to produce ball-like eologlyptoliths. Such forms have neither facets nor edges and cannot therefore be regarded as facetted stones *sensu stricto*.

Among these forms most important are the spheroidal eologlyptoliths i.e. the so-called „stone-rain" (Fig. 1: 16). Their shape is that of small round balls (10—15 mm in diameter) very well smoothed from all sides by wind-blown sand and dust grains. Such balls are never modelled by running water being clearly distinct from marine and lake pebbles which are rather flat or of a three-axial elipsoidal shape. „Stone rain" forms are probably modelled through rolling of isometric multi-facetted stones over the ground surface owing to which their edges are smoothed away.

Ellipsoidal or oval eologlyptoliths are rather rare. Their form by rolling of isometric multi-facetted stones over the ground liths are, no doubt, produced by the rolling and whirling action of wind upon elongated multi-facetted stones.

Cylindrical eologlyptoliths (Fig. 1: 18) are likewise uncommon. Their shape is that of short rollers with a perfectly polished surface and blunt ends. Also conical eologlyptoliths are rare (Fig. 1: 19). Such irregular conical forms are in fact re-modelled wedge-

-like facetted stones that underwent rolling over the surface or even clung with their heavier end to the ground.

Apart from the forms described above, other eologlyptoliths (Fig. 1: 20) display an interesting variety of shapes. They are unlike any geometrical body for they show a shapeless form, an uneven stone-surface, and a complete absence of facets and edges. Those eologlyptoliths are chiefly produced by selective weathering and deflation, for the less resistant rock particles are blown away while the more resistant and harder rock fragments form smooth projecting stone parts with intervening holes. Some of those eologlyptoliths exhibit curious shapes. They may be divided into isometric and elongate forms.

The above classification of eologlyptoliths presented here by the writer, is based, according to their structural properties, on the characteristics of the stone-surface sculpture. Therefore, the following main groups of eologlyptoliths may be distinguished: (1) polished with a definitely smooth lustrous stone surface; (2) opaque, without any glaze; (3) with miniature holes on a wind--worn surface — produced by strokes of wind-blown sand grains; (4) caverneous or etched, with spaced round miniature holes (the stone surface resembles a poch-marked face after smallpox); (5) with a honeycomb-like surface; (6) fluted or grooved with a strongly characteristic surface pattern of narrow and tortuous non--oriented grooves; (7) radial — with radially oriented grooves on the surface; (8) patterned — characterized by a disorderly arrangement of grooves forming a peculiar pattern on the surface.

With reference to their mineralogic composition, eologlyptoliths may be defined as: quartzitic, flint-, feldspar-, pegmatite-, aplite-, granitic, gneissic, dioritic, porfiritic, etc., according to the rock or mineral of which they are formed. Most of the samples in the present writer's collection are quartzitic eologlyptoliths; a few only consist of feldspar (orthoclase, microcline), pegmatite or aplite.

A very peculiar and significant feature of the eologlyptoliths consisting of pure feldspar or rocks containing feldspar grains is the very fresh appearance of that mineral that testifies to physical weathering under arid or semi-arid conditions. This refers also to the fossil eologlyptoliths of warm deserts and cold periglacial zones, provided the eologlyptoliths are still in their primary location and did not undergo subsequent weathering under humid conditions which contributes — as well known — to the decomposition of feldspars. Eologlyptoliths formed in the geologic past may contain

more or less weathered feldspars but the decomposition must have take place much later, after the eologlyptoliths were modelled. Thus, for instance, feldspar facetted stones occurring in Paleozoic and Mesozoic formations may show very strongly decomposed feldspar provided these formations outcroped in tropical or subtropical regions. In that case present-day organic and chemical weathering is likely to play an important role.

As a conclusion the writer presents the classification of eologlyptoliths according to their morphologic, structural and petrologic properties:

I. MORPHOLOGIC CLASSIFICATION

A. Eologlyptoliths with facets or facetted stones proper

1st group — flat or one-facetted stones (number of facets: 1, number of edges: 0), isometric and elongate forms

2nd sub-group — dioritic, diabasic, and of other green-tinded cets: 2, number of edges: 1) oval (ridge-roof-like), lancet-sickle-like, and irregular

3rd group — pyramidal (number of facets and edges: 3 and more):

1st sub-group — three-facetted stones (number of facets: 3, number of edges: 3), isometrical, lancet-, wedge-like, irregular

2nd sub-group — four-facetted stones (number of facets: 4, number of edges: 4), isometrical, rhomboidal, and irregular

3rd sub-group — multi-facetted stones (number of facets and edges more than 4), isometrical, irregular

B. Non-facetted eologlyptoliths

1st group — spheroidal ("stone rain")

2nd group — ellipsoidal, or egg-like

3rd group — cylindrical

4th group — conical

5th group — variously shaped, or irregular, isometrical and elongate

II. STRUCTURAL CLASSIFICATION

(a) depending on the rate of eolization

1st group — polished, with desert varnish
2nd group — opaque

(b) depending on the rate of stone sculpture

1st group — smooth
2nd group — smooth with traces of the impact of sand-grains on the stone surface
3rd group — caverneous, or etched
4th group — alveornous or honeycomb-like
5th group — ribbed, fluted
6th group — radial
7th group — patterned

III. PETROLOGICAL CLASSIFICATION

1st group — quartzic
2nd group — of flint
3rd group — of feldspar
1st sub-group — proper feldspar forms: of orthoclase, plagioclase, microcline
2nd sub-group — pegmatitic and aplitic
4th group — igneous, composed of various minerals
1st sub-group — granitic, gneissic, migmatitic, and of other light-coloured rocks
2nd sub-group — dioritic, diabasic, and of other green-tinded rocks
3rd sub-group — basaltic, gabbroic, peridotitic, pyroxenitic, and of other dark-tinted rocks
4th sub-group — porphyric
5th group — psammitic
1st sub-group — quartzitic
2nd sub-group — of sandstones and of metamorphic sandstones
6th group — aleuritic (of clastic rocks)
1st sub-group — aleuritic
2nd sub-group — diatomaceous
3rd sub-group — of tuffs and tuff-like rocks

7th group — pelitic
1st sub-group — of slates
2nd sub-group — of argillites
3rd sub-group — of opoka [1] (gaize, and gaize-like rocks)
8th group — carbonaceous
1st sub-group — of limestones
2nd sub-group — dolomitic
3rd sub-group — of marls

On the ground of the classification presented an exhaustive description of eologlyptolits is possible on the ground of their: shape, surface sculpture and mineral composition, e.g.: white quartzic two-facetted stone; dark basaltic ridge-like two facetted stone with grooves; pink quartzitic opaque spheroidal eologlyptolith; pitted greenish-grey diabasic pyramidal multi-facetted stone, etc.

Particular attention should be given to the presence of desert varnish, both black and brownish, in many cases spread over the whole eologlyptolith and obscuring the characteristic colour of the rock fragments. For instance, small eolized facetted stones of coloured quartzites, gray flints, yellow quartziteous limestones etc., covered with a thin (up to 1 mm) coating of black desert varnish, are very common in the periglacial zone of the Dneper glaciation. Owing to this coating the eolized rock fragments are strongly reminiscent of obsidian. The presence of a varnish coating is easily recognizable when fresh fractures are examined in various similar eologlyptoliths.

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