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On the Surface Character of Chert Clasta

Jun Yamada*

Abstract

Surface morphological characteristics of chert clasta are classified and described.

INTRODUCTION AND ACKNOWLEDGMENTS

Distinct surface characters have been recognized of the chert clasta from the terrace deposits distributed in several heights on the central Isé Plain, Mie Prefecture. The gravels of the terrace deposits were transported in part by paleostreams that flowed in the central area of the west coast of Isé Bay. The chert clasta collected from the said area can be classified into four types: The Isshi Group type, the Agé Group type, the Suzuka Mountains type and the worn type by their texture, especially surface character. The surface characters as described in this paper are recognized by the unaided eye or a low power magnifying glass. By the different types of chert clasta as well as lithological composition of the terrace deposits, classification was rendered possible by the relation of the terrace deposits to the position of the paleostreams.

Acknowledgments are due to Professor Kotora Hatai of the Institute of Geology and Paleontology, Faculty of Science, Tohoku University, for his sincere guidance and encouragement. Thanks are also due to Dr. Ichiro Kimura, Aichi Gakugei University in Aichi Prefecture, and Mr. Ichiro Mori, Seitoku Middle School, Mie Prefecture for their kindness in many ways.

GEOLOGICAL SETTING

Concerning the geology of the terrace deposits of the said area, Takehara and Kimura (1962) have outlined the Pleistocene System along the west coast area of Isé Bay, Mie Prefecture, and the stratigraphy of the area was published by Kimura (1971, 1972). The lithological analyses of the terrace deposits distributed in the central area was undertaken by Mori (1970) and Yamada (1970).

The latest work on the lithological analyses of the central area of the west coast of Isé Bay, was by Yamada, Kimura and Mori who investigated the lithological composition of the terrace deposits with the purpose to determine the position of the respective paleostreams. They used the index clasta and the percentages of the lithological composition in the terrace gravels and classified them into the types of "Paleo-Suzuka stream" containing black clay slate and hornfels of the Suzuka mountainland as the index clasta, "Paleo-Kumozu stream" containing plagiio-liparitic welded tuff of the Murô volcanics as the index clasta and others. They classified the terraces of the said area into four terraces; highest terrace, high terrace, middle terrace and low terrace. The terraces and the types of their paleostream are shown in Table 1. Their interpretation is: During formation of the highest terrace the Paleo-Suzuka stream was situated close to the Paleo-Kumozu stream near to Tsu City, as is judged from the distributions and lithological compositions of the Kentoyma Formation distributed in the northern and southern areas of Tsu City. At the time of the high terrace

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Table 1. The type of the terrace deposits in the environs of Tsu City, Mie Prefecture.

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<tr>
<th>Deposits</th>
<th>Area</th>
<th>Alluvial Deposits</th>
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<tbody>
<tr>
<td></td>
<td>The north side of Kumozu River, in the northern part of Tsu City</td>
<td>The drainage area of Nakano River, Kawage-cho, in the northern part of Tsu City</td>
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<td>The drainage area of Ane River, in the northern part of Tsu City</td>
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<td>Holocene Deposits</td>
<td>Komori Gravel</td>
<td>Chohoji Gravel</td>
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<td></td>
<td>(K)</td>
<td>(S)</td>
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<tr>
<td>Low Terrace</td>
<td>Hisai Formation</td>
<td>Takanoo Gravel</td>
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<tr>
<td>Deposits</td>
<td>(K)</td>
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<tr>
<td>Middle Terrace</td>
<td>Moroto Gravel</td>
<td>Kobayashi Gravel</td>
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<tr>
<td>Deposits</td>
<td>(K)</td>
<td>(K)</td>
</tr>
<tr>
<td>High Terrace</td>
<td>Kentoyama Formation (Aodani area) (K)</td>
<td>Kentoyama Formation (Kentoyama area) (S)</td>
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<tr>
<td>Deposits</td>
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<tr>
<td>Basement</td>
<td>Agé Group</td>
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(S): Type of Paleozo-Suzuka stream  (K): Type of Paleozo-Kumozu stream
(Revised after Yamada, Kimura and Mori, MS)

formation the terminal part of the southern part of the Paleo-Suzuka drainage area migrated farther north than during the time of the highest terrace formation, as can be interpreted from the Chisato Formation which is a deposit of the Paleo-Suzuka stream. At the time of the middle terrace formation the terminal part of the Paleo-Suzuka drainage area migrated farther south than during the time of the high terrace formation as recognized by the Nomura Gravel of the middle terrace, which is the end product of the southern part of the Paleo-Suzuka stream.

The character of the chert clasts seems to indicate the type of terrace sediment as is shown in the following.

**DESCRIPTION OF SURFACE CHARACTER OF CHERT CLASTA**

The terminology of the surface characteristics of the sedimentary clasts differ according to authors. According to Krumbine and Pettijohn (1938) the surface features of the rock fragments fall into three categories: degree of smoothness, degree of polish or gloss, and surface marking. Among these categories smoothness is the evenness of the surface, a smooth surface presents no megascopic features. And antithesis of smooth is surface marking on the large fragment. Surface marking may be distinguished as furrowed, grooved, ridged, scratched, and pitted or dented. On the small fragment the antithesis of smooth is rough. Rough may be distinguished as striated, faceted, frosted, etched and pitted. According to Wentworth (1936), the marking of features of glacial cobbles may be shown by scar (spall, etch and snob) and striae (parallel, scattered, grid and so on). And according to Maxon (1940), the types of surface feature may be distinguished as polish, fluting, grooving, faceting and rilling. Pettijohn (1957) mentioned that crescent impact scars or percussion marks are notable on the chert.
In this paper the author employs the following terms for the purpose to discriminate or classify the chert clasta of the area studied. Smooth is a condition where no megascopic features are observable, or is a surface slippery to the touch. And rough is the antithesis of smooth, and means that there may be various kinds of surface markings on the surface of the clasta.

The following terms are employed for the classification of the surface markings. Groove is a long and continuous depression. Rill is narrower than the groove of depression and resembles striae although the origin of rill is internal in origin whereas that of striae is external. Flute is a short and discontinuous depression and wider than groove. Pit is a round-shaped depression. Indent is a depression resembling an angular cut on the surface formed as if by sudden striking or pressing.

DESCRIPTION OF EACH TYPES OF CHERT CLASTA

The sedimentary clasta in the Isshi Group (Miocene), Mie Prefecture are contained in the basal conglomerate of the group. They consist largely of gneiss and granite and seldom of chert. These clasta have distinct surface features and their roundness degree indicate a marine deposit. The author found chert clasta resembling the clasta mentioned above in the Kentoyama Formation of Aodani; the highest terrace deposit in the southern part of Tsu City. Here, two typical specimens were found, one measures 54 mm × 49 mm × 35 mm in size; its shape is rather oval than spherical and is well rounded indicating the value of 0.8 of Krumbein’s scale. The outer surface of the clast is almost formed by a spherical plane and the surface character is generally smooth, though some surface markings are recognized. There is one fluting about 1.5 cm long. Its section is V-shape, of low dip and the edge with the outer surface plane is sharp. A groove is also recognized; it is remarkable and shows a straight line of about 5 cm long. It seems to be a continuous flute because its width and depth varies; the edge with the outer surface plane is sharp. Near the groove there are some faint rills which are as long as the groove and parallel to or vertical with it. There are some pits with sharp edge. Another specimen is described in the following. Its size is 16 mm × 15 mm × 11 mm, and the shape is a well rounded, half sphere. The outer surface of the half part is almost a spherical plane and the other half has a slightly wavy smooth. Surface markings consist of some faint rills and shallow triangle indent. The indent has basis about 2–3 mm long and the apex unite with the faint rills. It is the relic of the deep indent.

The character of the chert clasta of the Isshi Group type is as follows. Their shapes are spherical and the outer surface is smooth though a few markings are recognized. The outer edges at the surface of the depressions like groove, flute and pit are sharp and there are some faint rills.

The character of the chert clasta resemble the marine gravels of the Shima Peninsula, Mie Prefecture. Therefore it is considered that the chert clasta were derived from the marine deposit of the Isshi Group.

The clasta of the Agé Group type are contained in the basal conglomerate of the group. They consist of mainly subrounded chert and round quartz-porphyry admixed with gravels of Tertiary sandstone and siltstone.

The Agé Group is considered to have been deposited in a lake judged from the freshwater molluscan fossils. The chert clasta of the Oyama Conglomerate of the Agé Group at Ureshino-cho about 10 km south of Tsu City, are characterized as follows. There are two typical types of specimens of the Agé Group type. One shape is pseudo-tabular and the roundness degree is subrounded indicating the value of 0.5 of Krumbein’s scale. The outer surface is assembled to flat planes and the edges of their planes are rounded.
The surface of the flat plane is rather smooth. There are large indents of V-shape or U-shape with very low angle with round edges.

The other type has rather long pyramidal shape and is subround indicating the value of 0.5 of Krumbein's scale. The outer surface generally consists of flat planes with round edges. The surface of the clast is rough, and the surface are many parallel thin grooves extending in two directions, and there are also some step-like depressions due to the grooves.

Generally the clasta of the Agé Group are characteristic regardless of their size. The outer surface of the clasta consists of flat planes with round edges. There are some large indents of V-shape or U-shape with low angle and round edges.

The clasta derived from the Suzuka Mountains are sandstone, clay slate, hornfels, chert, granite, gneiss and others. The chert clasta are called the Suzuka Mountain type. The typical specimens were collected from the Kentoyama Formation at Kentoyama in the northern part of Tsu City. Their roundness range from angular to subangular indicating the value of 0.3–0.4 of Krumbein's scale. The outer surface consists of flat planes with rather sharp edges. The surface characters are rather rough and the surface markings are of thin grooves and indents. It seems that the thin grooves are the result of the cleavage in the chert clasta. The grooves are parallel or cross one another rectangularly and sometimes they are oblique to each other. The form of the indents are often pyramidal or prism-like with rather sharp edges. One or more planes of the indents are considered to have been formed by the splitting of the cleavages.

The clasta of the Suzuka Mountain type are characteristic in the following features. The outer surface consists of flat planes with rather sharp edges. They have some or many indents of which planes are considered to be the result of cleavage or fracture.

The clasta with weathering surface found in the upper part of the highest terrace and high terrace, are named the worn type. There are two typical specimens of the worn type from the Kentoyama Formation at Otani-cho in the northern part of Tsu City. One is a round clast and the other is a broken clast. Their surface characters are rough. The shape of the round clast is rather triangular with rounded degree of apex. The surface markings are of distinct grooves which seem to have suffered weathering. The grooves are divided into two types. One is of straight grooves; the original grooves before weathering seem to have suffered erosion. The other type consists of meandering grooves and betray evidence of solution effect on the original grooves which also show indents. Thus the surface plane is so worn that the surface appears as a wrinkle face. The shape of the broken chert is rather round with round degree of apex and angular degree of two apexes. The surface markings are of distinct grooves, flutes and pits. The grooves and flutes seem to continue to the pits, which are shallow but somewhat irregular holes and the clast has a large flat plane. The edge of the flat plane to the wrinkle plane is sharp. Thus the clasta of the worn type have distinct grooves, flutes and pits, consequently the surfaces appear as wrinkle faces. And the clasta often have large indents which make large split planes along the cleavages and when the indents become too large, they are called the broken clasta. The broken planes are generally uneven planes forming flat planes.

CHEM CLASTA OF EACH TYPES AND THE TERRACE DEPOSITS

The chert clasta in the area can not always be classified into the ones mentioned above. But when the classification is applied to the types found in the present area, the consideration can be made.

The chert clasta of the Kentoyama Formation at Aodani in the southern part of Tsu City contain the clasta of the Agé type and seldom that of the Isshi type. These are
inferred to have been transported by the Paleo-Kumozu stream that flowed through the Isshi Group and the area of the Agé Group. The Kentoyama Formation at Kentoyama in the northern part of Tsu City contain the clasta of the Suzuki Mountain type and Agé Group type, these are considered to have been transported by the Paleo-Suzuka stream flowing from the Suzuki Mountains and through the area of the Agé Group. The clasta of the worn type are found on or in the upper part of the highest terrace deposits and the high terrace deposit and sometimes the clasta reworked from the above mentioned terraces are found in the middle terrace deposits as Koriyama Formation and even in the deposits of the present river bed.

INTERPRETATION OF THE CHERT CLASTA

Due to the movement of the gravels by flood the loss of volume of the chert clasta are very small compared with the other kinds of rock clasta. This has been proved by Kuenen’s experiment (1956). It is considered that the chert clasta do not indicate small changes of the environments but are the result of large changes. Scott (1941) mentioned the process of solution sculpturing in limestone pebbles and Holmes (1960) stated on the evolution of till-stone shapes. Through the field observation of the chert clasta in the present and other areas, the following conclusion may be reached.

When the chert clasta are separating from a large block or mother rock, the chert block splits along the cleavage and the clasta thus attain flat planes and sharp edges. When the stream transports them, by their rotation their edges gradually become round but the clasta fail to change their flat planes to round planes. And by impact or traction the clasta attain indents of which plane is made by the cleavage or fracture. When the clasta suffer from the movements on the beach the clasta like chert will become of round shape and have smooth surface. Wearing by weathering, the clasta attain distinct sculpture of their surface and seem to have many wrinkles. When break occurs along the cleavage by some causes, large indents are developed and broken clasta are easily formed.

Concerning details of the worn chert clasta another paper is expected.

REFERENCES


Plate 53
(All in natural size unless stated otherwise)

Fig. 1. Clast of the Ishi type. There is a groove on the median part of the upper sphere, a flute on the right side, pits on the upper part and faint rills on the lower part of the clast.

Fig. 2. Clast of the Ishi type. There is a shallow triangular indent and rills extending from the apex of the triangular indent, especially a long rill stretches to the lower part. (× 3)

Fig. 3. Clast of the Agé type. There are large indents of U-shape on the upper part and of V-shape on the lower part.

Fig. 4. Clast of the Agé type. There are many parallel narrow grooves extending in two directions and step-like depressions.

Fig. 5. Clast of the Suzuka Mountain type. There is a prism-like indent.

Fig. 6. Clast of the Suzuka Mountain type. Many indents considered to have been formed by the splitting of the cleavages.

Fig. 7. Clast of the worn type. It shows a wrinkle surface and meandering grooves cross the straight grooves.

Fig. 8. Clast of worn type. This broken clast has grooves, flutes and pits, and the splitting is to the right side.

Fig. 9. A worn beach clast from the high terrace of the Shima Peninsula, Mie Prefecture.