RELATION OF THE CONE FRACTURE TO FLINT-LIKE MATERIAL

A cone of force is anything shaped more or less like a mathematical cone. A cone is a solid figure described by the revolution of a right-angled triangle about one of the sides containing the right angle, that side remaining fixed. If the fixed side be equal to the side containing the right angle, the cone is called a right-angled cone. If it be less than the other side, it is an obtuse angle cone; and if greater it is an acute angled cone. The axis of the cone is the fixed straight line about which the triangle revolves. The base of a cone is the circle described by that side containing the right angle which revolves. Similar cones are those which have their axes and the diameters of their bases proportional. The mathematical cone and the cone of force are comparable except that the apex of the cone of force is truncated and corresponds with the platform part or proximal end of a flake or blade.

In determinative mineralogy, a feature called conchoidal fracture is a surface more or less like the surface of a shell, and the term is characteristic of certain vitreous isotropic minerals. The term is used for identification of the fracture of minerals when they break, presenting on the negative side a concave surface like that of the interior of a bivalve shell and on the positive side a convex one like that of the exterior. The interior of the shell is the negative cone scar and the outside is the positive part of the cone. The hinge part of the shell is the cone truncation or the part receiving the force to induce fracture.

In determinative mineralogy the word "conchoidal" is used in ~~relation to the specific~~ combination with "fracture" to indicate the shell-like ~~surface~~ form ~~produced on~~ the surface of vitreous isotropic minerals ~~resulting from fracture is a type of fracture~~ lip fracture. In lithic technology the ~~word~~ conchoidal fracture ~~indicates a concave~~ indicates a concave ~~surface~~

Elasticity is the quality or condition of being elastic or springy: that inherent property in materials which allows them to recover their original form or volume after an external pressure or force has been dissipated. Elasticity is the utmost extent or limit to which elastic materials can be extended or compressed without fracturing. Vitreous or isotropic materials used in the lithic industries are almost perfectly elastic. Degrees of elasticity are dependent on the homogeneity of the micro-crystalline structure--the more vitreous, the more elastic. For example, obsidian and other glassy material are considerably more elastic and springy than quartzite; and natural flint is stiffer than thermally treated flint which has been made vitreous by artificial means. When vitreous material is worked, cones will either shear or be formed deeper into the mass than when approximately the same amount of force is applied to more granular material. The more granular material appears to dissipate the cone-forming force more readily than does the glassy material.

The term cone of force is used in this text to denote the visible part of the cone without implying the type of applied force. Many texts refer to the cone of force as the "bulb of percussion", thereby denoting that the cone part, or flake, was detached by the percussion technique. There are other techniques to flake detachment, and cones may be formed by pressure and indirect percussion. Unless one has evidence, such as flakes or flake scars bearing characteristics which determine the employment of certain technique, then it is better to use the term "bulb or cone of force". When the technique has been determined, it should then be signified by using the correct term--either "bulb of percussion" or "bulb of pressure".

Cone truncation occurs at the apex or proximal end of the cone of force and is called the platform part of the flake or blade. The top of the core is the platform and when a flake or blade (cone part) is removed a portion of the platform (cone truncation) is also removed. The size of the cone truncation is the area contacted by the percussor or compressor. The character of the cone truncation (platform) is the most diagnostic part of a blade or flake. The cone truncation may be flat or at an angle depending on the type of core or the applied technique. The truncations, or platform parts, are often modified by a variety of methods corresponding to techniques, stages of work, and the ultimate intention of the tool maker. Some truncations are simply the natural cortex of the stone, others a plane fracture surface, or the result from removal of two or more flakes to isolate the platform or truncation. Single bulbar scars are used to seat the flaking tool, and other truncations are strengthened by abrading and sometimes by polishing.

The yield of the percussion tool and the portion of the platform part contacted by the fabricator will make a large cone truncation and often eliminate the classic cone scar, leaving a diffused bulbar part on the flake and flake scar. The use of a hard semi-pointed or sharply convex hammer will leave a well defined cone scar. Some techniques cause the cone truncation to crush or collapse which leaves no visible bulb of force. The limit of elasticity must be exceeded to induce fracture in isotropic minerals. Sometimes when the worker is detaching a thick blade from the core, the blade will break when the rebound or recoil exceeds the elastic limit of the material. Rebound can be suppressed by reduced velocity, longer interval of contact or by dampening. Rebound fracture surfaces are an exception to the cone principle and cannot be compared to the cone of force.

When lithic material is subjected to stress, the force waves radiate in every-expanding waves and circles from the point of contact, compressing the material and causing a cone to be formed. When the applied force exceeds the elastic limit of the material, fracture results. Fracture starts at the apex or vertex of the cone and terminates at that basal margin. Therefore, the direction of applied force is different from the fracture angle of the cone. One must bear in mind that a flake scar which is derived from the fracture angle of the cone results from force which is applied at other than a right angle or perpendicular to the central axis of the cone and is tangential to the direction of fracture.

A common inverted funnel can be used to illustrate the cone principle. The stem of the funnel represents the direction in which force is applied. The sides of the funnel represent the fracture angle of the cone, and the apex of the cone (platform) is the part of the funnel where the neck or stem joins the flared part of the funnel. The funnel can be overlaid on the flake or cone scar and the stem of the funnel will indicate the direction at which force was applied. The flare of the funnel sides may not be quite the same as the angle of the cone, but the stem can indicate the approximate direction of force. One can make an isosceles triangle from cardboard or a piece of plastic and affix the apex of the triangle to a small dowel to be used as an indicator to determine the direction of force. The gauge will resemble an inverted "Y". The angles of the isosceles triangle's sides should correspond to those of the cone of force. This small tool is a useful device for showing the direction of applied force to remove a flake or blade from an artifact or core. The gauge helps in discriminating between nature facts and artifacts. The gauge helps to determine the angle ~~in~~ at which force was applied and when the angle or angles represented by flake or blade scars are known, one may then reconstruct the action that was involved in the forming of the core or implement. There are exceptions to the rule of using the fracture angle of the cone to determine the direction of force; e.g. (1) splitting or shearing of the cone by opposing bi-polar forces ~~when~~ due to inertia, and (2) cone collapse due to excessive compressive force.

Should a row of flake scars removed in sequence be present along a margin indicating consistent directions of force applied with the same intensity, the probability is that it was a product of man's endeavor, rather ~~that~~ than a result of natural action. ~~The row of~~ Man-made flake scars ~~must~~ will generally all bear the same amount of erosion. insert Erosion differential will indicate that the flakes were removed at different times. Differences in erosion will be more characteristic of nature than of man's remodification of an artifact. The angles of force causing sequential flake detachment from alternate directions

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along a margin would be unlikely in a natural action. Violent disturbances from natural causes in vitreous materials can produce single objects resembling artifacts, but they will not occur in numbers that show preconception of design and intent.

The type of applied force determines the formation or spacing of the compression rings around the circumference of the cone. The compression rings undulate in different degrees of intensity, comparable to water or sound waves. For example, blows of high velocity delivered with a hard hammersone cause the wave interval to be closely spaced, while a slow blow with a soft percussor will cause the wave interval to be widely spaced. Soft hammer wave intervals approach those produced by pressure. The waves seem to be quite regular pulsations that start at the apex of the cone and continue to the termination of the cone fracture. surface irregularities

Prehistoric stone tools of flint-like or isotropic materials are generally made by applying sufficient force to lithic material to exceed its elastic limit, thereby inducing fracture and detaching a portion of the stone. The detached piece is a flake but is also a cone part. Some flakes are half cones, others are quarter cones or parts of cones. Full cones result from force directed in from the margin at 90° on a right angle margin and quarter cones are formed by the force being directed vertical to the corner of a rectangular block (fig.). The detached material can assume a variety of forms: all will have a complete or portion of the cone of force. These parts removed from near the margins are called flakes. Some flakes is placed on the tabular material to be perforated and the piece of hard wood is secured by the hand at one end and the opposite end is pulled back. When it is released it strikes the small pebble and the impact perforates the material by removing a cone. Shattering is common until the correct velocity is achieved.

Another full cone experiment involves selecting a piece of lithic material with a natural flat surface, or by making a flat surface to receive the impact, and then imbed the stone in wet sand. The plane surface is placed upward and then struck vertically with a hard percussor. The size and velocity of the percussor must correspond with the size and inertia of the objective piece. This method will perforate the piece by removing a full cone, but until one becomes proficient at the technique, he will have more failures than successes.

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Since cones and cone parts are the result of force applied to isotropic materials, they may be the result of either natural or human force applied by pressure or, more commonly, by percussion. Natural forces result from a wide variety of causes and may, under the right conditions, form cones and cone scars on stone which will be similar to those made by man. However, natural scars on lithic material are generally random and do not reflect the preconception, planned order, rhythms and muscular motor habits necessary for man to produce his tools. Close examination and analysis of the scar character and the fracture angle of the cone of force will indicate the direction of applied force and may reveal that they are a natural random imitation rather than pre conceived and calculated human endeavors. Flakes intentionally detached by man have sharp edges and generally leave sharp edges on the objective piece prior to performing functional chores. Utilized tools may exhibit dulled edges but generally have a distinctive wear pattern. Natural fractures produce flakes and cores with abraded edges due to indiscriminate pressure and percussion.

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Natural cones of force are common in lithic deposits where movement occurs. Natural movements of rocks, whether by changes of elevation or water action or any force or forces which cause contact by pressure or percussion, can induce cones of force on the fractured stone. However, in this case, the negative bulb of force will be more noticeable in vitreous stone with isotropic properties than in granular rocks. One pebble striking another will form a cone of force on both pebbles if the force exceeds the elastic limit of the material. The cone will penetrate the material equivalent to the amount of force, the inertia and the velocity. Reduced force may not form a cone on the stone while great force may cleave the object at the fracture angle of the cone. If the material is resting on an unyielding support and the force is directed opposite the support, it is possible for the cone of force to be sheared. Vitreous stone which is rolled and tumbled for some distance will soon be covered with intersecting cones which penetrate at different depths because of the variable intensities of force. This is a good gauge for selecting suitable material for making tools. Vitreous rocks having this cratered surface are generally superior material for stone tool manufacture. Non-vitreous