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Micro-craters in muddy tidal flats of cold regions

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Article abstract

Meltwaters dripping from overhanging ice cakes, stranded at low tide on muddy tidal flats of the St.Lawrence Estuary, near Québec City, cause micro-craters to form on soft mud and silty-sand sediments. The shallow depressions are circular, symmetrical, and with rims a few mm high, some have a tiny hole centered in the bottom. Craters range from 7 to 15 cm in diameter, and 20 to 50 mm in depth ; they characterize tidal flats of cold regions.

MICRO-CRATERS IN MUDDY TIDAL FLATS OF COLD REGIONS

Micro-craters, or so-called impressions in muddy sediments, are generally caused by falling substances or bubbles. Falling substances include rain, hail, drip, spray, and splash, or any other substances that fall from the sky, especially substances dropped by birds. Bubble impressions originate variously : anchored bubbles, bubbles from the expelled air of overflowed surface, bubbles floating in waters, and bubbles from decayed organic matter.

Recent and fossilized micro-craters have been reported for more than a century (Lyell, 1851 ; Warren, 1855 ; Wyman, 1855). Half a century ago, Twenhofel (1921) described various types of impressions or micro-craters and discussed their origin. Kindle (1916) reported on small pits produced by air escaping from underlying sediments. Recently, Blackwelder (1941) discussed the significance of rain prints, and Maxon (1940) the origin of gas pits. These minor structures are sometimes a useful criterion for determining the environment and distinguishing top layer in ancient consolidated rocks with complicated structures. According to Shrock (1948, p. 139), these imprints exhibit almost limitless variety of shapes and origin, and many have not been satisfactorily explained.

The purpose of this note is to briefly describe a type of micro-depression that, to our knowledge, has not been reported.

The impressions discussed in this note were discovered in the process of formation on a tidal flat of the St. Lawrence Estuary, near Quebec City, in spring 1971. A series of rimmed circular depressions (photo 1), ranging from 7 to 15 cm in diameter, and 20 to 50 mm in depth, with rims 10 to 15 mm high rising over the general surface, were seen at low tide. The shallow depressions, some with a tiny hole centered in the bottom, are produced by meltwater drips falling from overhanging ice cakes stranded in the intertidal zone. Some of the craters, usually in a series of 5 to 12, are characterized by an outlet allowing excess meltwater to escape. A few depressions are coalescent, others partly superimposed.

Crater dimensions are determined by the velocity of the drips that hit the ground and the hardness of the mud, and velocity is determined by the rate of ice melting and the height drops fall. If the mud is very soft, it flows and impressions are not formed.

The micro-crater structures produced by meltwaters differ from structures made by rain, hail, splash, or bubbles, in three ways : (1) They are circular, symmetrical, deeper and larger ; (2) rimmed ; (3) sometimes

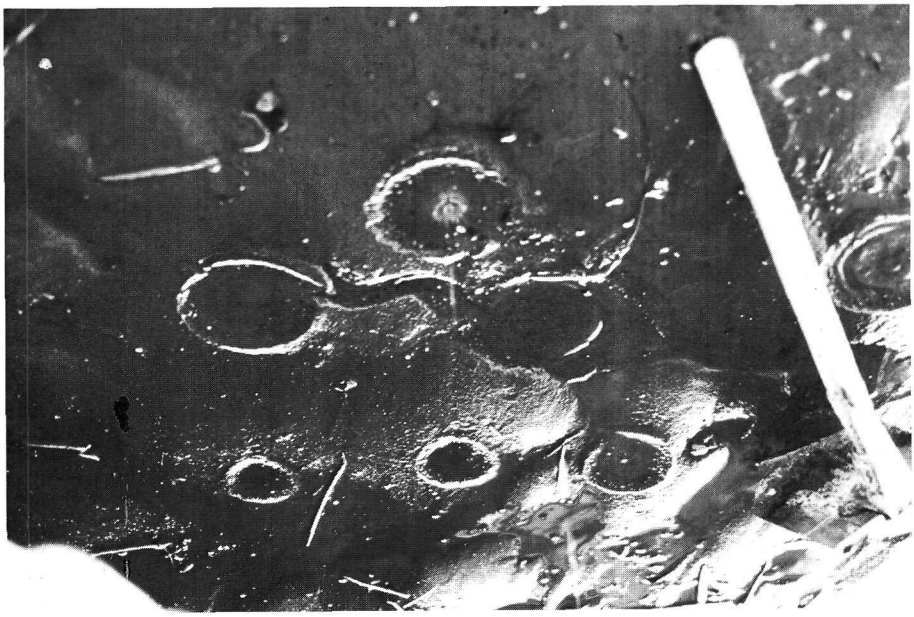

Photo 1 *Micro-craters in muddy sediments produced by meltwaters dripping from an overhanging ice cake stranded in an intertidal zone at low tide. Note rimmed depressions, tiny hole centered in the bottom, dripping water in one crater, and outlets through which depressions are drained. (Photographed near Quebec City, Canada, April 1971).*
Micro-cratères d'origine glacielle dans des sédiments vaseux de la zone intertidale, près de Québec. À remarquer le bourrelet périphérique, la cavité minuscule au centre de la dépression et les exutoires de déversement. Les dépressions sont produites par les gouttes d'eau de fonte d'un glaçon échoué sur l'estran.

they have an outlet and a tiny hole centered in the bottom. They are generally found in a group.

Similar micro-crater features, observed today in the process of development might be found in ancient consolidated rocks, even though none have been reported. However, preservation conditions are not usually very good ; most structures seem to be destroyed before being buried. It is hoped the example reported in this paper will draw the attention of sedimentologists to consider the meltwater process of formation when discussing the origin of micro-craters in muddy sediments.

Drip impressions reported by Twenhofel (1921, pp. 363-364), were attributed to drips falling from trees and overhanging cliffs. Usually tidal flats are located away from cliffs and devoid of trees and shrubs, so that the origin suggested by Twenhofel should be disregarded. Micro-craters observed so far in tidal flats were generally attributed to gas escaping from underlying sediments (Buckland, 1842 ; Martin, 1904 ; Klippel, 1939) ; although depressions made by drips of meltwater bear some resemblance

to gas pits, and can occasionally be mistaken, they must not be confused with them.

If preserved in the geological strata, the micro-crater features may be a useful criterion on which to establish the identity of top and bottom layers, and characterize their environment, which is exclusive to tidal flats in cold regions.

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ABSTRACT

Meltwaters dripping from overhanging ice cakes, stranded at low tide on muddy tidal flats of the St.Lawrence Estuary, near Quebec City, cause micro-craters to form on soft mud and silty-sand sediments. The shallow depressions are circular, symmetrical, and with rims a few mm high, some have a tiny hole centered in the bottom. Craters range from 7 to 15 cm in diameter, and 20 to 50 mm in depth ; they characterize tidal flats of cold regions.

RÉSUMÉ

Les gouttes d'eau de fonte de glaçons échoués, à marée basse, dans la zone intertidale des rivages vaseux de l'estuaire du Saint-Laurent, produisent de petites dépressions circulaires et symétriques, avec des rebords de quelques millimètres de hauteur et parfois une cavité minuscule centrée dans le fond. Ces dépressions ont entre 7 et 15 cm de diamètre, 20 à 50 mm de profondeur et sont caractéristiques des rivages des régions froides.