

GEOLOGY

Rim Structure of the New Quebec Crater,
Canada

THE New Quebec Crater is a circular lake-filled depression, two miles in diameter, in the acid Archaean gneisses of northern Quebec (61°3' N., 73°6' W.). A bedrock rim encircles the crater rising 1,300 ft. above the crater floor, and 300 ft. above the surrounding barren lands. The rocks of the rim consist of quartzo-feldspathic gneisses identical to those outside the rim except for various degrees of hydrothermal alteration. The structure of the rim is unique, and is a relatively recent deformation of the regional Precambrian structure. Curvilinear structure elements are shown in Fig. 1. The vertical north-trending gneissosity common to the gneisses of this region is systematically deformed in the rim such that strikes are radial to the crater. Precambrian faults crossing the rim are deflected as much as 30° toward the centre of the crater. Analysis of the grid defined by gneissosity and faulting shows that the diametrical distance between two points on opposite sides of the crater has been decreased 2,500 ft. by this deformation. Rock sheeting is approximately horizontal outside the rim, but in the rim dips radially outward at angles varying from 10° to 85°, averaging about 33° (ref. 1). These results show that the rim is the remnant of a structural dome, approximately a spherical cap 18,000 ft. in diameter and 2,000 ft. high. The arc distance across this cap is 2,600 ft. longer than the diameter, and the inclination at the edge is 33°.

Epidote is common in the rim rocks, occurring as seams, diffuse patches, and large perfect crystals, but is rare or absent in similar rocks outside the rim. Sericite is abundant in the rim rocks, but is not found in rocks outside the rim.

Impact origin for this crater was postulated 15 years ago² because of its topographic form; but detailed geological investigations in 1962 failed to discover meteorite fragments, highly shocked or shattered rocks, shatter cones, or any evidence of a catastrophic explosive event. Material previously thought to be throw-out from an impact³ was shown to be felsenmeer.

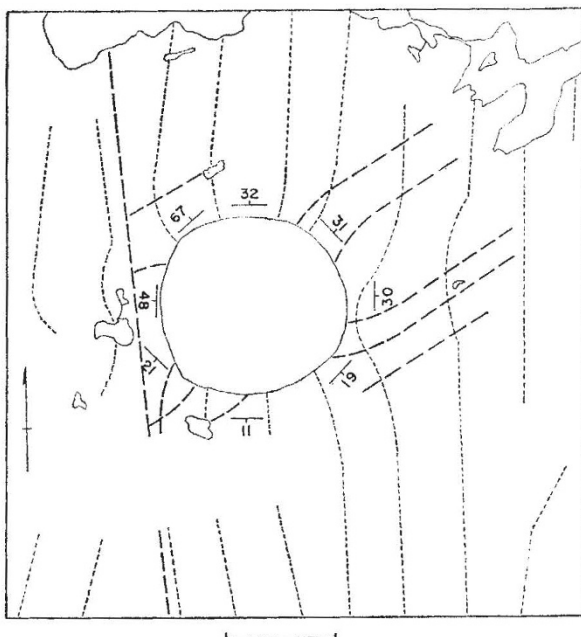


Fig. 1. Structural elements in the new Quebec crater region. Heavy broken line, trace of faults; light dashed line, trace of gneissosity; strike and dip symbols, average strike and dip of sheeting. The scale bar is one mile long

The absence of ejecta, presence of hydrothermal alteration, and structure of the rim, suggest the crater originated by collapse of a dome supported by hydrous fluids. This model predicts a lens of breccia beneath the crater, composed of rock formerly in the crater and the overlying dome. If the crater and the overlying dome are approximated by spherical caps 11,000 ft. in diameter, with depth 1,300 ft. and height 1,500 ft. respectively, and if it be assumed that the rock expanded in volume by 10 per cent on crushing, the volume of breccia is 1.58×10^{11} cubic ft. The volume of breccia found by Innes⁴ in the Brent Crater, which is of similar size, is 1.91×10^{11} cubic ft. The coincidence suggests that gravity anomaly comparable with the -5.5 milligals found over the Brent Crater will be found over the New Quebec Crater. This prediction has recently been confirmed by Innes⁵.

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¹ Currie, K. L., and Dence, M. R., *Nature*, **198**, 80 (1963).

² Millman, P. M., *Pub. Dom. Obs. Ottawa*, **18**, No. 4 (1956).

³ Shoemaker, E. M., *Amer. Sci.*, **50**, No. 1, 124 (1961).

⁴ Innes, M. J. S., *J. Geophys. Res.*, **66**, No. 7, 2227 (1961).

⁵ Innes, M. J. S., *Meteoritics* (in the press).

Graptolites in the Indian Sub-continent

ALTHOUGH geological work has been in progress in India for well over a century, an important lacuna—the absence of graptolites in the sub-continent—had remained unbridged until quite recently when one of us (V. J. G.) made this interesting find. The conviction that this lacuna would be bridged one day was emphasized by the senior author as long ago as 1941¹ and again successively in 1956², 1962³ and 1963⁴.

The earliest reference to the possible occurrence of graptolites in India is by Lyddeker⁵ which is also quoted by Middlemiss⁶. However, no authentic record was known and, despite the extensive field investigations of the Geological Survey of India and other field parties, the gap remained unbridged. Later, Cowper Reed⁷ discussed certain differences supposed to exist between the Himalayan and Shan (Burmese) life provinces in pre-Carboniferous times, notably the absence of graptolites in the former. La Touche⁸ was obviously influenced by the presumed lack of graptolites in the Himalayas when he postulated the presence of an 'unsurmountable barrier' between the Himalayas and Burmese regions from the Ordovician until the close of Silurian times. According to La Touche, well-preserved specimens of *Didymograptus* were discovered by Coggin-Brown from the Pu-pjao Beds of Yunnan which he considered equivalent to the Naung-kangyi (Ordovician) formation of the Southern Shan States. Cowper Reed⁷ has referred to the discovery of graptolites in the Southern Shan States by V. P. Sondhi. That assemblage apparently indicates, according to Gertrude L. Elles (in ref. 9, p. 210), the *Monograptus cyphus* Zone (Silurian), also known from the Panghsa-pye graptolite band of the Northern Shan States.

When discussing the Lower Palaeozoic of India and Burma and its faunal anomalies Sahni⁹ observed: "The absence of graptolites in the Himalaya is considered further evidence of lack of affinity between the Burmese and Himalayan Ordovician. But graptolite horizons are notoriously elusive, and too much importance cannot be attached to them, especially where such highly folded rocks as of the Himalayas are concerned, and graptolites may yet be found in the Himalaya. In this connexion, the discovery of graptolites (genus? *Diplograptus*) in Iran may be cited". Sahni⁴ again referred to these anomalies in his Holland Memorial Lecture: "The complete absence of graptolites in the Himalayas also needs careful and early attention. It would be unfortunate, indeed, to leave the gap unbridged for I feel certain that the graptolite facies will be found in the Himalaya one day. It must be