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DEPARTMENT OF SUPPLY AND SHIPPING.

BUREAU OF MINERAL RESOURCES
GEOLOGY AND GEOPHYSICS.

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(Geol. Ser. No. 8)

WOLF CREEK METEORITE CRATER

by

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CANBERRA, A.C.T. 4th February, 1949.

DEPARTMENT OF SUPPLY AND DEVELOPMENT

BUREAU OF MINERAL RESOURCES
GEOLOGY AND GEOPHYSICS

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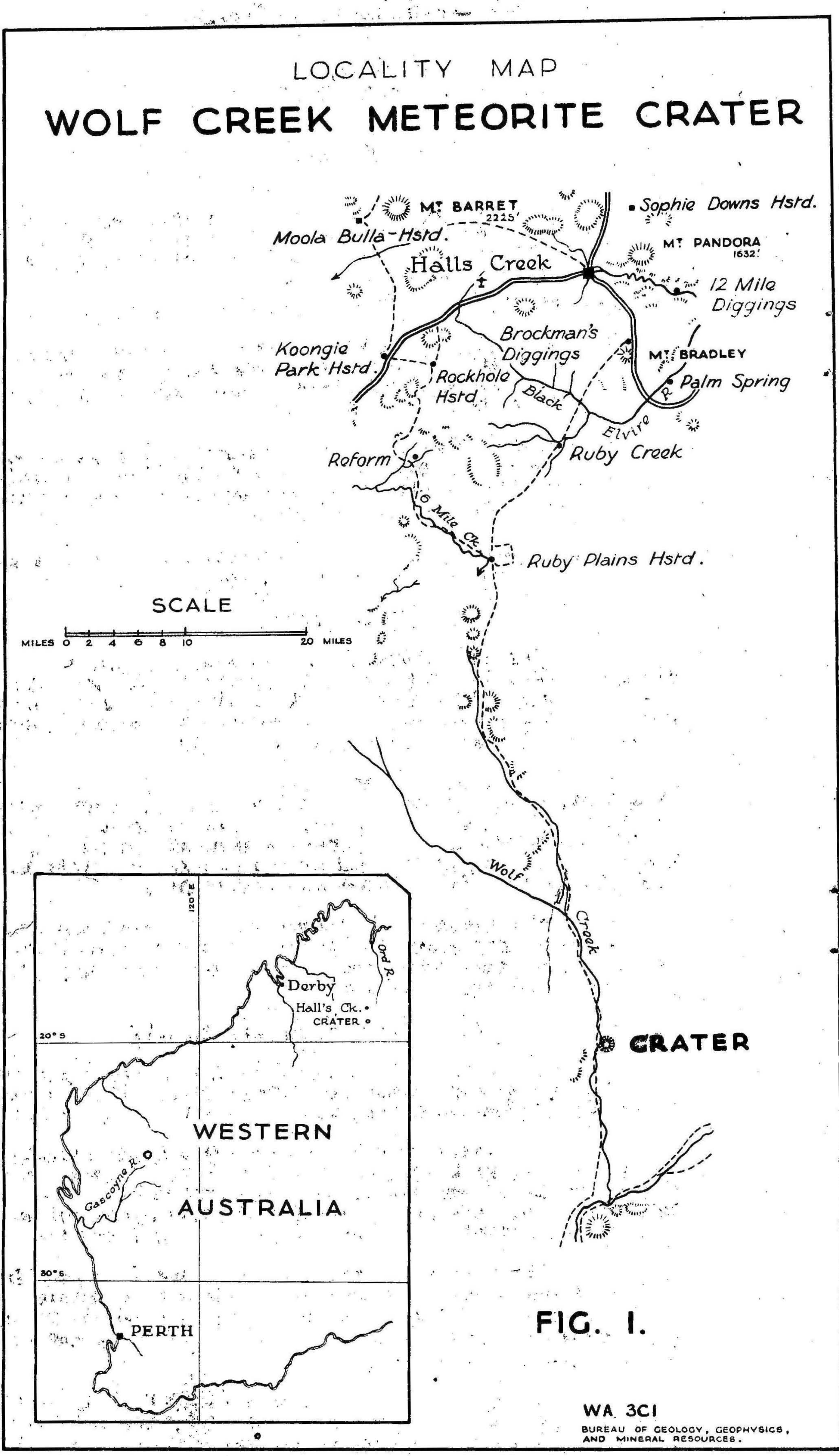

FIG. I.

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WOLF CREEK METEORITE CRATER.

Report No. 13.
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I. SUMMARY.

1. The Wolf Creek Crater is the second largest crater of meteoritic origin to be discovered on the earth's surface. An outline of the history of the discovery of the crater is given.

2. The situation of the crater is described.

3. A general description of the crater is presented including dimensions, appearance, types of sediments involved and structure of the crater. An interpretation of these factors is given.

4. A general discussion follows with emphasis on meteoritic craters as distinct from craters resulting from other causes. A tabular comparison of craters of known meteoritic origin is given.

5. Evidence in favour of a Pleistocene to Recent age for the crater is presented.

II. INTRODUCTION

The Wolf Creek Meteorite crater situated in the Kimberley District of Western Australia is the second largest crater of meteoritic origin to be discovered on the earth's surface. The crater has been named by Dr. Reeves (Reeves, 1948) after the adjacent watercourse, Wolf Creek.

The nature of the crater was first recognised on June 21st, 1947, by Dr. Frank Reeves and N.B. Sauvé of the Vacuum Oil Company during an aerial reconnaissance of the Desert Basin in a Zinc Corporation aircraft piloted by Dudley Hart. It was reached on the ground on August 24th, 1947, by Reeves, Harry Evans and Dudley Hart.

The crater was independently located and its meteoritic origin suspected by one of the writers (D.J. Guppy) early in 1948 when preparing a photo-geological map from photographs covering the area.

III. LOCATION AND DESCRIPTION

The crater is situated on the northern edge of the Desert Basin at approximately 127°46' east, 19°18' south, 65 miles south of Halls Creek, the nearest township and aerodrome.

The crater may be reached without difficulty during the dry season by taking the track from Halls Creek to Rubey Plains homestead and thence to Beaudesert Well. Near Beaudesert Well a branch track is followed along the west bank of Wolf Creek as far as the crater. (Figure 1).

The crater is situated in an area covered with loose sand with occasional low sand dunes and sparse vegetation a few miles south of the last observed outcrops of Nullagine quartzites and grits of Pre-Cambrian age. Nullagine quartzites are exposed in the crater.

The crater, from the Beaudesert Well approach, appears as a low hill in an otherwise featureless area and from a distance there is nothing to suggest the existence of the crater behind the rise.

As the hill is approached more closely the piles of broken rock forming the rise are seen more clearly and the peculiarities of the hill become more obvious.

The general appearance when viewed from the foot of the rise is unique. The massive pile of unsorted blocks of red-brown quartzite particularly on the southerly flank of the crater rim is very striking.

The view from the top of the rim is most imposing and the perfection, that is to say the symmetry and uneroded condition, of the crater must be seen to be believed.

The average depth of the crater below the rim is 160 feet or an average depth of 70 feet below general land surface. The original depth of the crater was somewhat greater as the inner portion of the crater has been partly filled by an unknown depth of sediment.

The average maximum thickness of broken rock forming the rim of the crater is 90 feet and this consists of angular blocks and pieces of quartzite and grit thrown up by the explosion of the meteor.

The appearance of the crater in detail may best be described by reference to the west-east and south-north sections in the accompanying diagram (Figure 2) and composite photograph.

The near symmetry of the crater is readily seen from the sections (Figure 2). The height of the rim rock varies but little around the circumference and any variations that do exist may be attributed partly at least to subsequent erosion. The outer slope of the shattered rock varies from 10 to 15 degrees and the inner slope of the wall of the crater ranges from 30 to 40 degrees and no doubt closely approximates the original outline as there is little evidence of erosion.

The floor of the crater is essentially flat with a very slight rise from the central area to the abrupt face of the wall. The inner portion of the floor, diameter 1400 feet, is composed of light porous gypsum with a number of sink-holes. Surrounding this central area is a zone covered with loose sand extending to the wall.

The quartzites forming the wall have a general low dip outwards e.g. 20° on the eastern wall where the dip is well defined and elsewhere as much as 50 to 60 degrees. Inward dipping strata occur in parts of the south-west and north-west sectors of the wall.

Apparent dips are in places deceptive as what may appear to be the dip of the strata in the wall rock may be a large loose block or a slumped portion of the wall rock. Both are common around and on top of the wall and in some sections it is difficult to recognise the true attitude of the strata.

Very sharp bending of the beds is clearly visible on the northern wall of the crater. It is difficult to assess when examining the structure of the crater which characters are to be attributed to the regional structure and which should be attributed to the force of the exploding meteor. The Nullagine sediments examined to the north of the crater are gently folded and faulted on a small scale. It seems reasonable to postulate that the general outward dip of the beds forming the wall of the crater is due almost entirely to movement resulting from the explosion of the meteor.

Similar structure has been established in the cases of the Meteor Crater of Coconino County, Arizona (Barringer, 1909) and Texas Crater in Ector County, Texas (Barringer, 1929). It is likely that the bending described from the north wall of the crater is partly at least a structure of pre-meteor age as it would appear impossible for surface beds of hard quartzite to bend in such a way without considerably more fracturing.

WOLF CREEK METEORITE CRATER

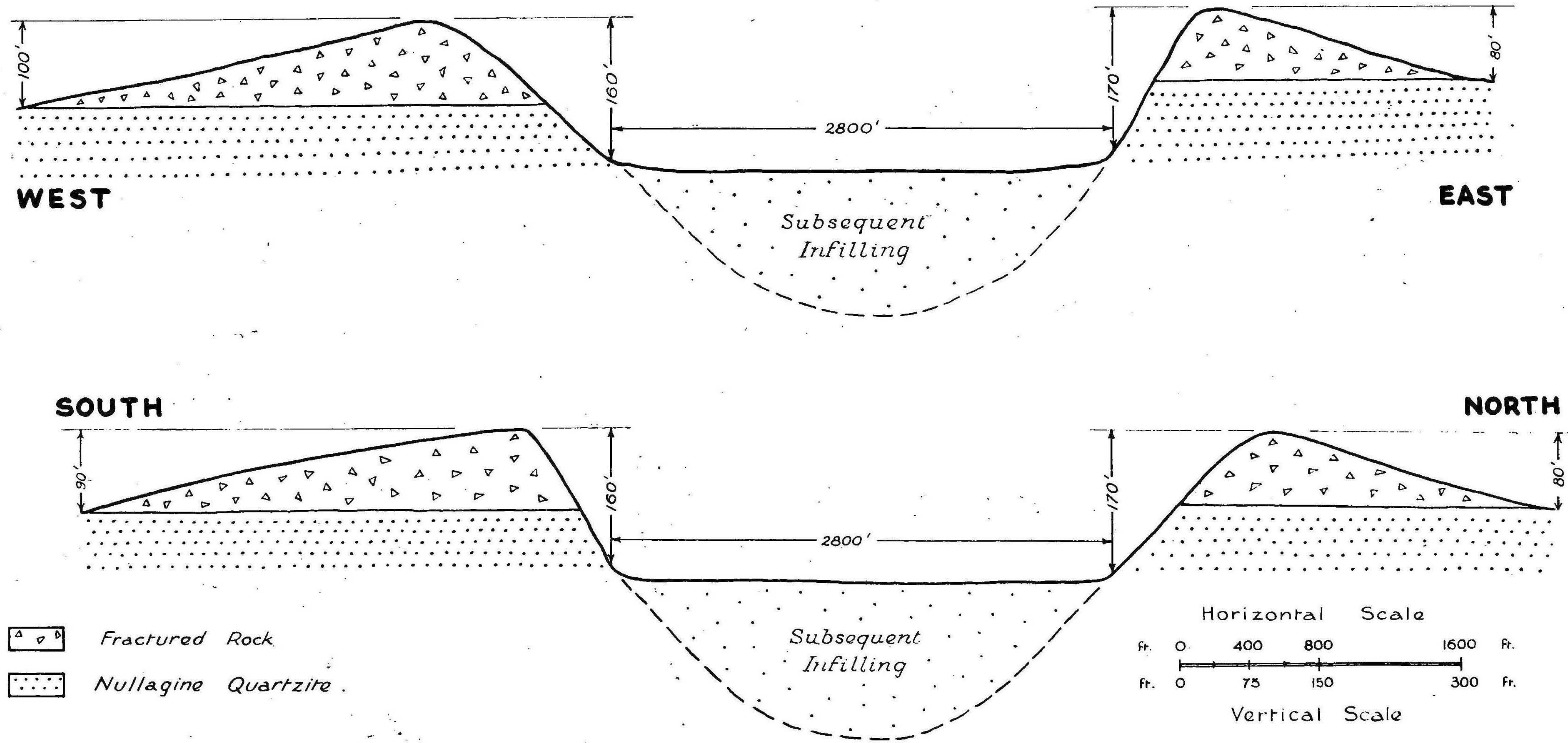

FIG. 2.

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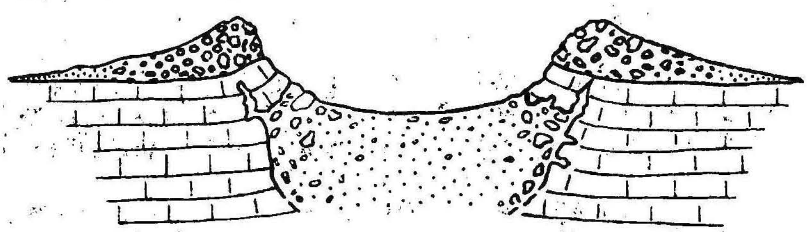
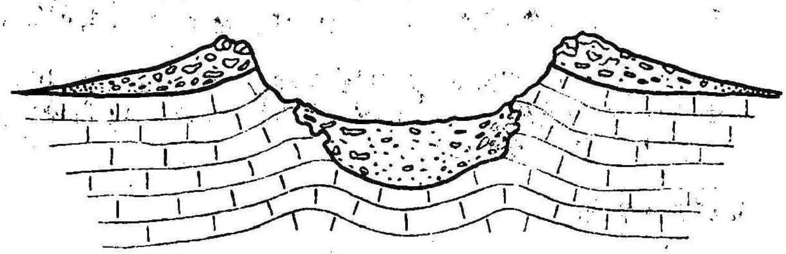
DIAGRAMMATIC SECTIONS
of a
TYPICAL METEORITE CRATER

From the "Geographical Journal" 1933.
After Dr. L. J. Spencer.



Fracturing and tilting of strata by outwards explosion.



Ring Anticline by percussion.

FIG. 3.

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An examination of the crater both on the ground and from aerial photographs gives the impression that a greater volume of fractured rock has been piled around the south-west portion of the crater suggesting that the meteor was moving in an arc from the north-east towards the south-west when it struck the ground.

From a study of craters on the earth's surface and on the moon, Deitz (1946), and others have suggested that the radial symmetry and circularity of craters such as the Meteor Crater and those on the moon's surface are due to exploding meteors. Explosion craters, in contrast to percussion craters, have circular shape and well developed radial symmetry regardless of the angle of incidence. (Figure 3).

No silica glass or sintered rock has been discovered in the area but there is every probability that further work will disclose the presence of material of this character.

Fragments of various size of heavy metallic material were found around the rim of the crater particularly along the southern sector.

R.O. Chalmers, Curator of Minerals of the Australian Museum, has advised "that the specimen contains 1.9% of NiO which is far in excess of what would be expected in terrestrial rock".

Samples of meteoritic iron were submitted to the Western Australian Government Chemical Laboratories. The following information is quoted from their report.

The samples consisted of two fragments A and B.

A weighed approximately 300 grms. and B. approximately 500 grms.

The material is sufficiently magnetic to allow fragments of pea-size being lifted by a bar magnet and consist mainly of iron oxides, hydrated in part, with some silicate minerals too highly impregnated with iron oxides to be identifiable, and a little chalcedony.

After fine grinding, specimen A yielded a very small amount (0.06%) of metallic iron which was retained on a 90 mesh screen.

<u>Analysis</u>.

	A	B
	per	cent.
Nickel, Ni in metallic portion	3.71	-
Nickel Ni total	3.57	4.47
Specific Gravity	3.42	3.80

IV. GENERAL DISCUSSION

An interesting paper by Nininger (1948) covers the geological significance of meteorites. It took scientists many years to accept the fact that matter from outside the earth and its atmosphere was falling and had fallen on the earth's surface. Today there are still some who will not accept the meteoritic origin of some craters.

It is apparent that studies of craters such as the Meteor Crater, Arizona, Barringer (1909, 1915), Boxhole Crater, Central Australia, (Madigan 1937), Texas Crater (Sellards, 1927, Barringer, 1929), Henbury Craters (Alderman, 1932), Wabar Craters (Philby, 1933), Campo del Cielo Craters (Någera, 1926), Siberian Craters (Whipple, 1930) and now the Wolf Creek Crater in Australia have produced an overwhelming amount of evidence in favour of this meteoritic origin. The Wolf Creek Crater gives further support to the theory of Dietz (1946) and others who postulate a meteoritic origin for craters on the moon's surface.

From the available literature it appears that six craters or groups of craters of meteoritic origin have been described (Spencer, 1933) while a further two, namely, Ashanti Crater, occupied by Lake Bosumtwi, Ashanti (Maclaren, 1931) and a group of craters in Estonia (Reinwaldt, 1928 and Kraus, Meyer and Wogener, 1928) remain doubtful. Niningor (1948) also mentions that in addition to the fall of meteors in Siberia in 1908 "now comes word that a similar, though smaller collision has occurred at a point some 200 miles north of Vladivostock".

The following table of the dimensions of craters of proven meteoritic origin is of some interest. The variations in the ratios of width to depth may be explained by either erosion and sedimentation or an initial accumulation of shattered rock or both. The actual depth to bed rock is investigated.

	Width	Depth	Ratio of Width to Depth
Meteor Crater, U.S.A.	3900 feet	570 feet	6.8
Wolf Creek Crater, Australia	2800 "	170 "	16.5
Boxhole Crater, Australia	575 "	52 "	11.1
Texas Crater, U.S.A.	530 "	18 "	29.4
Henbury, Australia	360 "	60 "	6.0
Henbury, Australia	240 "	25 "	9.6
Henbury, Australia	30 "	3 "	10.0
Wabar Craters, Arabia	328 "	40 "	8.0
Campo del Cielo Crater, Argentina	183 "	16 "	11.4
Siberia Crater, U.S.S.R.	164 "	13 "	12.5

V. AGE OF THE CRATER

Unfortunately the youngest sediments in the area occupied by the crater are Pre-Cambrian in age.

During the examination of the crater a few loose pieces of pisolitic ironstone or laterite were noticed amongst the fractured blocks forming the rim of the crater on the eastern side. On descending the wall of the crater the layer of laterite, from which loose pieces were derived, was located in situ in the wall.

This evidence proves that the meteor struck the ground and exploded after the laterite layer had been formed. Information which has been accumulating over the last few ucars favours the late Miocene as the age of the laterite in Northern Australia. It is, therefore, fairly certain that the Wolf Creek Crater was formed later than Miocene times.

The erosion of the crater is slight and signs of erosion on the steep walls of the crater are not well marked.

As far as could be ascertained aboriginals in the area have no record of the meteor in their legends but are aware of the crater.

Summing up the evidence points to a Pleistocene or Recent geological age for the crater.

VI. BIBLIOGRAPHY.

Alderman, A.R., 1932 : The Henbury (Central Australia) Meteorite Iron. Records of the South Australian Museum, Vol. 4.

Barringer, D.M., 1909 : Meteor Crater in Northern Central Arizona. Read before National Academy of Sciences November, 1909.

Barringer, D.M. Jnr.1929: A New Meteor Crater. Proceedings Accd. Nat. Science, Philadelphia. Vol. 80.

Chamberlin, R.T., 1945 : The Moon's Lack of Folded Ranges. Journal of Geology. Vol. LIII.

Dietz, R.S., 1946 : The Meteoritic Impact Origin of the Moon's Surface Features. Journal of Geology. Vol LIV.

Hodge Smith, T., 1939 : Australian Meteorites. Memoirs of the Australian Museum, Sydney. Memoir VII.

Kraus, Meyer and Wegener, 1928 : "Untersuchungen über den Krater von Sall auf Ösel", Gerlands Beiträge sur Geophysik, Vol. 20.

Maclaren, M., 1931 : Lake Bosumtwi. Geographical Journal Vol. 78.

Madigan, C.T., 1937 : The Boxhole Crater and the Huckitta Meteorite. Trans.Roy.Soc.South Australia, Vol. 61

Nágera, J.J., 1926 : "Los hoyos del Campo del Cielo y el meteorite". Dirreción General de Mines, Geologia e Hidrologia, Argentina, Buenos Aires, publ. no. 19.

Nininger, H.H., 1948 : Geological Significance of Meteorites. American Journal of Science. Vol. 246.

Philby, H.St.J., 1933 : Rub' Al Khali : An Account of Exploration The Geographical Journal. Vol. 81.

Reeves, F., 1948 : Wolf Creek Crater. Unpublished report to Vacuum Oil Co. Pty. Ltd., Australia.

Reinwaldt, I., 1928 : "Bericht über geologische Unter suchungen am Kaali järv (Krater von Sall) auf Ösel" Tartu Ulikooli juures oleva Loodusuurijat Seltsi Arunnded (Sitzungsber. Naturfora. Gesell. Uni. Tartu). Vol. 35.

Raynor, J.M., 1938 : The Henbury Meteorite Crater and Geophycial Prospecting. The Australian Journal of Science. Vol. I.

Sellards, E.H., 1927 : Unusual Structural Features in the Plains Region of Texas. Bull. Geol. Soc. America. Vol. 38.

Spencer, L.J., 1933 : Meteorite Craters as Topographical Features of t he Earth's Surface. Geographical Journal. Vol. 81.

Whipple, F.J.W., 1930 : The Great Siberian Meteor and the Waves, Seismic and Aerial, which it produced. Quarterly Journal of the Royal Meteorological Society, London. Vol. 56.

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PANORAMA OF INTERIOR OF CRATER.

AERIAL PHOTOGRAPH OF CRATER.