LETTERS TO THE EDITOR

ANOMALOUS ETCH PITS IN BISMUTH

FRAWLEY AND CHILDS[1] have reported the etching of the (111) faces of bismuth with hydrochloric acid and obtained triangular pits for short duration of etching and pseudohexagonal pits on prolonged etching. These pits are formed at dislocation sites and their shape has been explained on the basis of the different unit cells of bismuth. Vaghari[2] has reported the development of unusual etch pits on the (111) faces of bismuth at sites of heterogeneities by etching them in solutions of chromium trioxide and glacial acetic acid. The present author has reported the observation of etch pits of different types on the (111) faces of deformed bismuth crystals using an etchant consisting of equal parts of fuming nitric acid and glacial acetic acid[3]. These pits are produced at dislocation sites. In the present communication evidence of etch pits having unusual characteristics observed occasionally in some of the samples is reported.

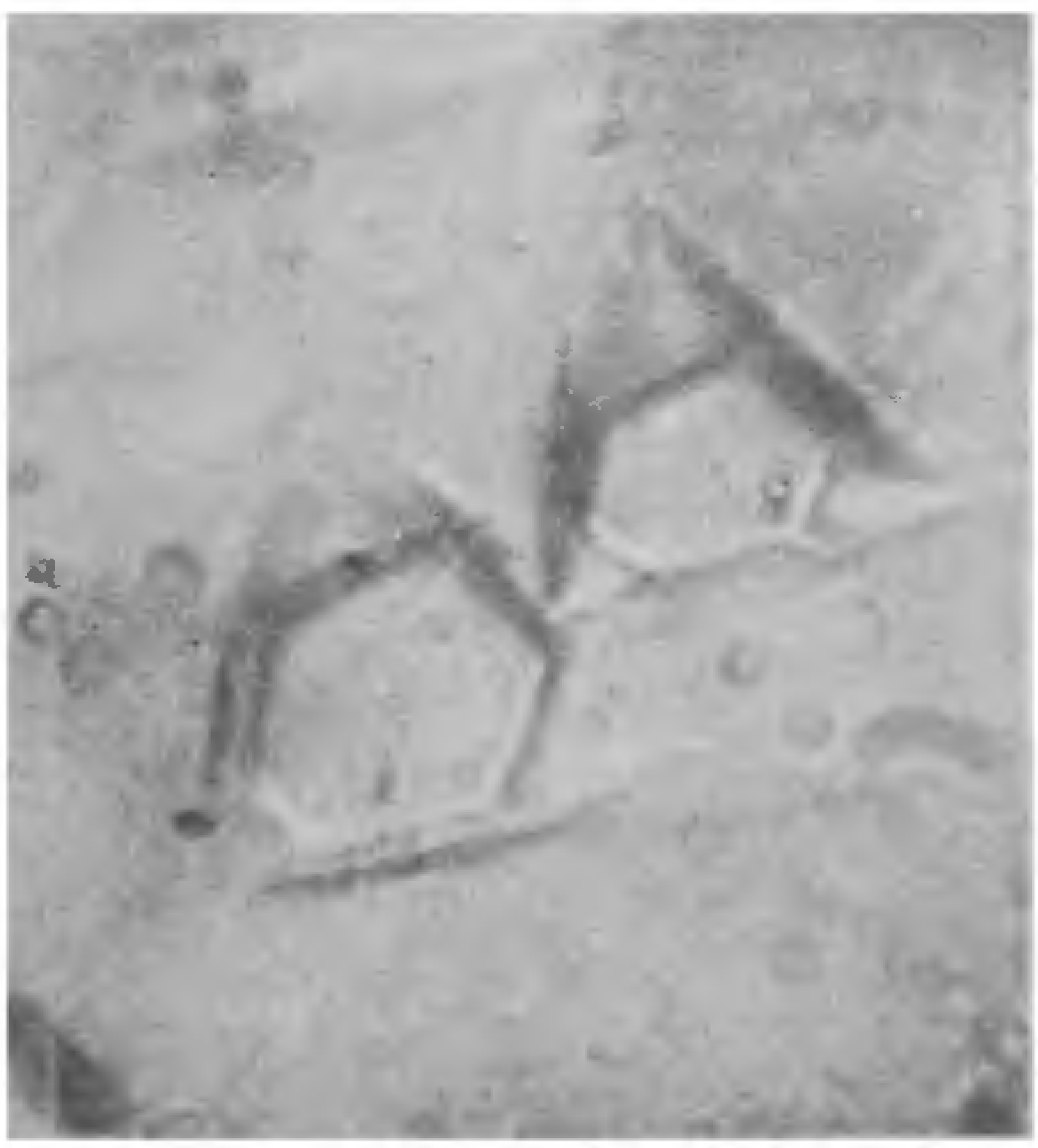

FIG. 1

Single crystals of bismuth were grown from the melt by the Bridgman technique from metal of 99·990% purity. The crystals were grown at lowering rates below 5 cm/hr in a temperature gradient of 7·5° C/cm. Crystals were cleaved at liquid nitrogen temperatures along the (111) planes, rinsed in ether and dried. The crystals were etched in the etchant reported earlier[3]. In a very few samples on etching for 20 sec, triangular pits having pseudohexagonal bases were observed randomly distributed over the surfaces along with the usual triangular pits which were point bottomed. Figure 1 shows a pair of such pits.

Bismuth has a rhombohedral structure and it can be described by two different unit cells. The face centered rhombohedral unit cell is made up with three equal angles of 87° 34′ and the primitive rhombohedral unit cell is made with three equal angles of 57°, 14·2′. As the metal used was not of very high purity, the anomalous pits observed are formed at sites where reasonable amounts of impurities might have collected. In the initial stages the (100) faces of the face centered rhombohedral unit cell constitute the faces of the triangular pits which at later stages start incorporating the sides of the (100) faces of the primitive rhombohedral cell. This would then give rise to the type of pits shown in Fig. 1.

The author is thankful to Prof. N. S. Pandya for his interest in this work.

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1. Frawley, J. J. and Childs, W. J., *J. Appl. Phys.*, 1970, 41, 1862.
2. Vaghari, D. J., *Ind. J. Pure and Appl. Phys.*, 1970, 8, 672.
3. Shah, B. S., *Curr. Sci.*, 1972, 41, 632.

THE EXPANDING EARTH—AN EVIDENCE FROM PALAEOMAGNETIC OBSERVATIONS IN INDIA

IT has been proposed by Carey[1], Heezen[2], Egyed[3] and others from geotectonic evidence that the radius of the earth has been increasing during geological history. It has been further pointed out that the area of the continents has not increased; and the increase in the global area resulting from the increase of the earth's radius is associated only with the widening of the oceanic basins. Hilten[4] used the direction of remanent magnetism of rocks to determine the average radius of the earth in the geological past. He showed that the ancient radius of the earth R_a could be given by

$$R_a = p.R/\cot^{-1}[(1/2)\tan I]$$

where R is the present radius of the earth, p is the geocentric angle between the sampling site and

TABLE I

Rock Type	Geologic age	λ_{ON}	$L_{\circ E}$	I	λ_p	L_p	p	R_a (Km)
Carlsberg Ridge	.. Miocene	5·0	62·0	−40	56S	37E	64·2°	6082
Satyavedu Sand Stones	.. Lower Cretaceous	13·5	80·0	−38	26S	113E	62·3°	5776
Tirupathi Sand Stones	.. do.	17·0	81·0	56	28S	107E	50·5°	6026
Sylhat Traps	.. Upper Jurassic	25·0	91·0	−59	16S	120E	48·7°	6166
Raj Mahal Traps	.. do.	25·0	88·0	−64	13S	111E	43·5°	6489
Parsora Sand stones	.. Triassic	23·5	81·0	−39	30S	125E	63·3°	6282
Himgir sand stones	.. Permian	22·0	84·0	−44	30S	122E	57·0°	6141
Purple sand stones	.. Cambrian	32·7	73·0	32	28S	32E	68·3°	5988
							Average ..	6120 Km

the ancient pole position and I is the dip of the magnetisation.

Hilten calculated the earth's radius considering pairs of localities from North America, Western Europe and Siberia and the values reported by him varied from 4,000 Km to 8,800 Km with an average of 6027 Km which is 5·5% less than the present value. In the present note, an attempt has been made to calculate the radius of the earth during the geological past from palaeomagnetic results in India by a direct application of the above-cited formula.

The palaeomagnetic results considered here are taken from Bhimasankaram and Pal[5], and the details of calculations are incorporated in Table I, including the latitude (λ) and longitude (L) of the site, dip of magnetisation (I) and ancient latitude (λ_p) and longitude (L_p) of the pole. The geocentric angle between the ancient pole position and the sampling site is obtained by the cosine rule of Spherical Trigonometry. The ancient radius of the earth calculated is also incorporated in the last column, which averages out to be 6,120 Km, which is fairly below the present value of the earth's radius. Thus the palaeomagnetic observations in India clearly support the hypothesis of the expanding earth.

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Waltair, *January* 5, 1973.

1. Carey, S. W., *Continental Drift Symposium*, Univ. of Tasmania, 1958, p. 177.
2. Heezen, B. C., *International Oceanography Congress Reprint* 26, Washington, 1959.
3. Egyed, L., *Nature*, 1963, **197**, 1059.
4. Van Hilten, D., *Ibid.*, 1963, **200**, 1277.
5. Bhimasankaram, V. L. S. and Pal, P. C., *Proc. of Second Symposium on Upper Mantle Project*, Hyderabad, 1970, p. 228.

CONE-IN-CONE STRUCTURE FROM THE WEST BOKARO COALFIELD, INDIA

THE purpose of the present note is to report the occurrence of cone-in-cone structure in a coal seam in India.

Cone-in-cone structure is produced due to cleaving along series of sub-parallel "cone" surfaces due to abnormal type of cleavages, more or less replacing the usual partings or cleats.

In 1924 Potonié (1924) described a type of structure as a pyramid-forming structure (Pyramidenkohle) in the coals of Germany. Later, a similar structure was referred to by Tarr (1932) in the coals of England and Wales as cone-in-cone structure. In 1934 Price published the first record of its occurrence in the U.S.A. Later, Fyfe and Wellman (1937) found cone-in-cone structure in the coals of New Zealand.

The cone-in-cone structure, as shown in Fig. 1, was found in a sample of coal collected from

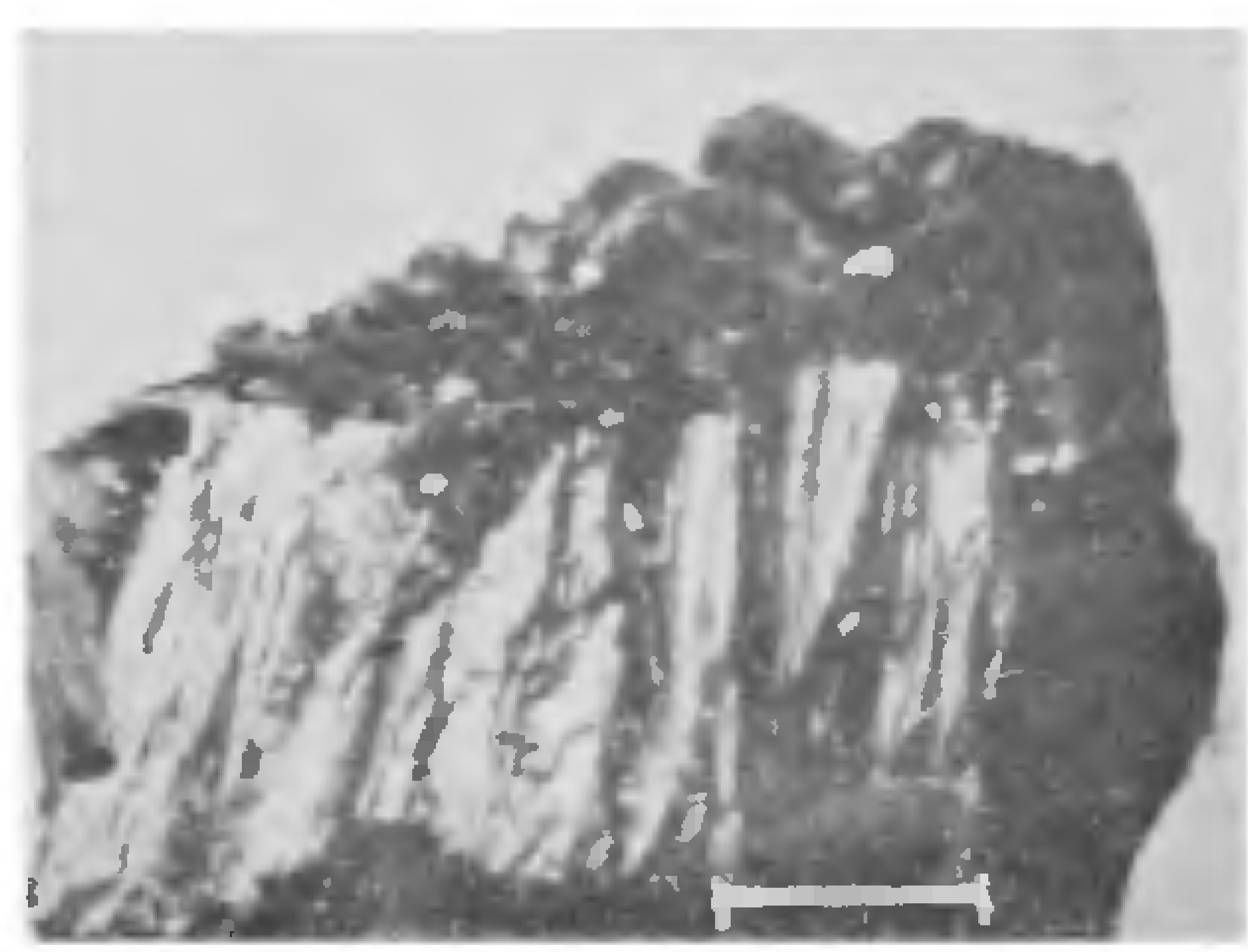

FIG. 1. Photograph showing cone-in-cone structure. The scale at the bottom is equivalent to 1 cm.

seam No. X (also called Kuju seam) from 5/7 incline of the Kuju colliery (23°43′ : 85° 30′) in West Bokaro coalfield. The sample consists of alternate bands of vitrain and durain, but the