ism. Both $CaCO_3$ and $(Mg,Fe)CO_3$ retain their axial relationships parallel to the original phase. $(Mg,Fe)CO_3$, thus formed from dolomite and ankerite, transforms immediately into MgO and FeO at that high temperature. The reason for not observing any lines due to FeO may be low particle size and also the small percentage of FeO formed. The mechanism of transformation of $(Mg,Fe)CO_3$ will be the same as that of $MgCO_3$ whose transformation has already been described (Dasgupta, 1964). It has been suggested there that the transformation of $MgCO_3 \rightarrow MgO$ takes place by an inhomogeneous transformation where for every 2 $Mg^{2+}$ ions migrated from the donor region one $C^{4+}$ ion migrates in the opposite direction from the acceptor region in accordance with the suggestion made by Dent Glasser, Glasser, and Taylor (1962). The $[111]_{rh}$ of $MgCO_3$ crystal then becomes $[111]_{cub}$ of MgO crystal whereas the three diad axes of the rhombohedral $MgCO_3$ are interchanged with the three diad axes of cubic MgO. $CaCO_3$, formed from dolomite and ankerite, also transformed into CaO at higher temperature. But as CaO is very unstable and absorbs moisture from the air readily, no texture pattern due to CaO was observed; instead, the powder patterns of CaO and $Ca(OH)_2$ appeared.

13/2A *Ballygunge Station Road,*
*Calcutta-19,*
*India.*

D. R. DASGUPTA

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## *Further mineralogical data on native lead balls*

METALLIC balls were first found and described by Standard (1964) in the Hawkesbury Sandstone, which is briefly described by Bayliss *et* *al.* (1965). One hundred grams of this rock were disintegrated with a rubber stopper and hard rubber pad to yield 0·15 % heavy minerals. Of the 44 samples examined, 15 samples were found to contain a total of 164 balls; 76 balls in one sample, forming the bulk of the heavy minerals in its coarse fraction, 34 balls in a second sample, and a few balls in each of the other samples. Their location is widespread both stratigraphically and geographically throughout the entire deposition area, and also they were found in three samples stratigraphically below the Hawkesbury Sandstone. All were found in the +0·35 mm size fraction. They are rounded, malleable, and non-magnetic. Their pitted surface has a purplish-peacock sheen and a bright metallic lustre. Some have tails protruding from them similar to the tail of a volcanic bomb; some have slight indentations; and two were joined together by a tail. This appearance suggests a molten source.

These metallic balls were identified by X-ray diffraction as lead with a cubic unit-cell size of 4·952 Å compared to 4·950 Å given for pure lead by Swanson and Tatge (1953). The impurities in the lead balls indicated by spectrographic analysis are: $SiO_2$ 2–1 %; $Fe_2O_3$ 1 %; $Al_2O_3$ 0·2 %; CaO 0·2–0·1 %; MgO 0·2–0·1 %; $B_2O_3$ 0·1 %; $TiO_2$ 0·05 %; MnO 0·01–0·005 %; CuO 0·003 %; and NiO 0·001 %. However both the impurities, silver and antimony, mentioned by Palache *et al.* (1944) are absent. The percentage abundance of lead isotopes is the following: 204 1·43±0·01; 206 23·98±0·19; 207 22·07±0·12; and 208 52·53±0·13. This abundance is identical with the conventional abundance of lead isotopes given in the compilation by Rankama (1963) and each of the ratios $^{206}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$, and $^{208}Pb/^{204}Pb$ on the data of Russell and Farquhar (1960) indicates a formation age of 1000 million years ago. However this age is 5 times older than the 200 million years old Triassic Hawkesbury Sandstone. The fine crystal size in these balls is indicated by both polished block studies and the very fine X-ray diffraction lines without a trace of spotting on a Debye-Scherrer powder photograph of a single ball.

The extreme rarity of native lead and the doubtful validity of many reported occurrences is stated by Palache *et al.* (1944). The origin of the balls is speculative, but transportation is rejected due to their large size and low hardness. A possibility is authigenic formation similar to that for the dickite in this rock as deduced by Bayliss *et al.* (1965), or it may form by biological concentration although fossils are rare.

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*School of Applied Geology,*
*University of New South Wales,*
*Kensington, N.S.W.*

P. BAYLISS
J. C. STANDARD

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## *The determination of feldspars by flame photometry*

FRASER and Downie[1] have described two procedures for determining the 'diagnostic elements'—potassium, sodium, and calcium, in feldspar samples. Their flame-photometric method involves the direct determination of potassium and calcium (and hence of orthoclase and anorthite), and calculation of albite by difference. Their spectrographic method, which they consider the more rapid, involves the visual estimation of intensities of a dozen different spectrum lines, followed by use of a 'determinative chart'. Both methods require the use of previously analysed samples of microcline, albite, and labradorite as standards.

Readers of Mineralogical Magazine may be interested in knowing of a less complicated solution to this relatively simple problem. The proposed method[2] involves flame-photometric determination of the three diagnostic elements. In order to overcome inter-element effects (mainly that of aluminium on calcium), standard solutions are prepared by blending synthetic solutions whose compositions correspond to the end members of the plagioclase and alkali feldspar series. The effects of residual small differences in composition between samples and standards are eliminated by the addition of magnesium as a 'releasing agent'. The method has also been applied, with encouraging results, to the

[1] W. E. Fraser and G. Downie, Mineralogical Magazine, 1964, vol. 33, p. 790.

[2] Sydney Abbey, Canadian Mineralogist, 1965, vol. 8, p. 347.