

THE NEGATIVE CRYSTAL CAVITIES OF CERTAIN GALENA AND THEIR BRINE CONTENT

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ABSTRACT

Galena from certain localities, notably Joplin, is characterized by containing numerous voids. In simple cases, these are cubo-octahedral negative crystals; in other instances, they are more complicated catacomb-like voids based on the cubo-octahedral motif. These are brine filled; on breaking the crystal, the brine crystallizes as sodium chloride cubes in parallel position with the galena. Head has previously described these cubes, implying that they occurred as halite contemporaneous with and intergrown with the galena.

Head¹ has recently called attention to the sodium chloride content of galena. He implies that the salt occurs as solid halite, and that the age of the salt is roughly contemporaneous with that of the galena, for he says, in part:

The existence of *halite* on galena surfaces is a matter that affords some grounds for amplification, at least theoretically. The mere fact of its presence is suggestive and might serve for entertaining the premise of the possible occasion of other soluble

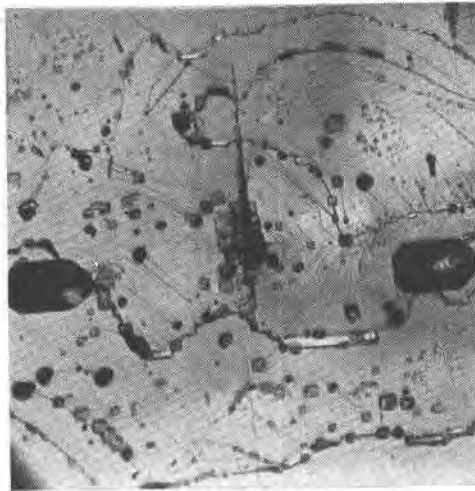


FIG. 1. Negative crystal cavities of cubo-octahedral habit in Joplin galena, $\times 18$. The little squares are sodium chloride crystals which have precipitated on the cleavage surface from the brine contained in these and nearby cavities.

¹ R. E. Head. The Cleavage Surfaces of Galena: *American Mineralogist*, **16**, 1931, 348-350.

or insoluble salts as *natural surface constituents* on sulphide minerals [Italics by M.J.B.].

The present writer contends that the sodium chloride is present as brine in negative crystal voids in the galena, and that evaporation of this brine precipitates the sodium chloride on the new cleavage which exposes the cavity.

NEGATIVE CRYSTAL VOIDS. Negative crystals are of common occurrence in galena, especially in the Joplin galena. The smaller examples of these voids are essentially simple and tend to duplicate the normal habit of the crystal exterior in the negative, but with rather a marked tendency toward rounding of all edges and corners. Thus, the usual negative crystal habit of the Joplin galena is cubo-octahedral, as shown in Figure 1. Larger examples have more irregular shapes although it is usually not difficult to discover the cubo-octahedral motif upon which they are based (Figure 2).

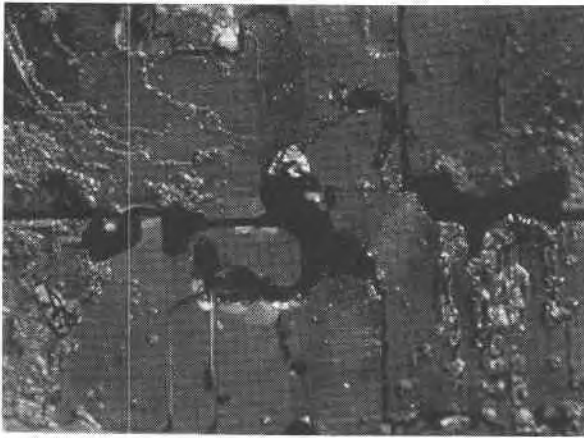


FIG. 2. Connecting voids in Joplin galena, $\times 18$. This photograph was taken by combined normal and oblique illumination. The chains and masses of light material are sodium chloride crystals precipitating on the cleavage surface from brine derived from these cavities.

In order to gain a correct background for an understanding of the origin and placement of negative crystal cavities in galena, it is necessary to refer the reader first to a previous article devoted to the discussion of *lineages*.² Examination of a large number of

² M. J. Buerger. The Significance of Block Structure in Crystals: *American Mineralogist*, 17, pp. 177-191, 1932.

negative crystal cavities of different types brings out the fact that a considerable proportion of them occur obviously in lineage boundaries (Figure 3). Because of the impossibility of gaining a correct appreciation of the third dimension in an opaque mineral like galena, and in view of the plausibility of the idea, as explained below, it appears very probable that most, or perhaps all, of the negative crystals do actually occur in lineage boundaries, and that those which do not show an obvious connection with this feature, probably would if a cleavage somewhat above or below the one under examination could be seen. The origin of the rather profuse negative crystals of Joplin galena probably thus comes about largely as an irregular growing-over of the exterior surfaces of crystals whose lineages have forged ahead independently in such a way that the exterior of the crystal takes on the appearance, in a somewhat less extreme fashion, of a group of crystals "in parallel position." This origin accounts for the fact that crystals rich in lineages are also rich in irregular negative crystals.



FIG. 3. Cleavage surface of Joplin galena, $\times 65$, specimen slightly tipped to display lineages. The two rounded black areas about half an inch across, in the right and left lower centers, are negative crystal cavities. The blocks of various shades and irregular shapes are lineages. The occurrence of negative crystals at lineage boundaries is obvious.

In line with this is the presence of catacomb-like cavities or systems of cavities connected by tabular openings (Figure 2), and

linearly arranged strings of cavities. The line of connection or line of alignment in the case of unconnected cavities, is evidently some lineage boundary. This may or may not be indicated on the cleavage surface examined, because of the third dimension difficulty. The outermost systems of catacombs usually connect directly with the exterior of the crystal. When this is the case the surfaces of the cavities are frequently either corroded or filled with various other minerals, usually the common secondary products. In all other instances, the interior surfaces of the negative crystals are exceedingly lustrous and show no signs whatever of any alteration. In some cases normal, brilliant crystal faces may be made out in the interior, in others, the interior has an appearance somewhat akin to that of the surface of irregular fused lumps of glass. Head's term, "pebbled" evidently refers to some of these surfaces of special type which are well described by this term. Similarly, Head's allusion to slickensiding (page 347, legend to Head's Figure 2) evidently comes from very beautiful rounded examples of oscillation striations.

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Mr. Head is correct when he says that sodium chloride occurs with some of the galena crystals, but the writer believes he is incorrect in implying that sodium chloride occurs as halite. As a matter of fact it occurs as salt water in negative crystal voids of the crystals; on breaking the cube of galena, the salt water spreads and covers the bright new cleavage surface and on evaporation crystallizes as salt in parallel orientation with the galena. The evidences for this correction are as follows:

(a) Mr. Head's photograph given as his original Figure 3, showing halite on the galena cleavage, indicates that the sodium chloride is *on* the new galena cleavage and did not grow *in* and *with* the galena, to be exposed by later cleavage. This is clearly indicated by the fact that the sodium chloride crystals have preferentially chosen the regions of *tear lines*³ as foci of crystallization. The tear lines can be seen through the transparent cubes. They must, therefore, antedate the cubes, for it is clear from the very nature of tear lines that it would be impossible to form them under other crystals. Furthermore, assuming that the sodium chloride was

³ A discussion of these is given in: M. J. Buerger, The Cleavage Surfaces of Galena; to appear in a later issue of *The American Mineralogist*.

present as crystals in the galena, the cleaving of the galena would have required the simultaneous cleaving of the sodium chloride crystals. There is no trace of this in the photograph.

(b) Artificial sodium chloride will precipitate as crystals in parallel position on a galena cleavage surface, from evaporation of a concentrated water solution.

(c) On breaking a large number of galena crystals from Joplin, not one was found to have intergrown halite, but many were found to have cavities filled with brine. The cavities are in the form of regular to complex negative crystals, as previously described. The cavities have highly lustrous, metallic surfaces, with not a trace of corrosion in evidence.

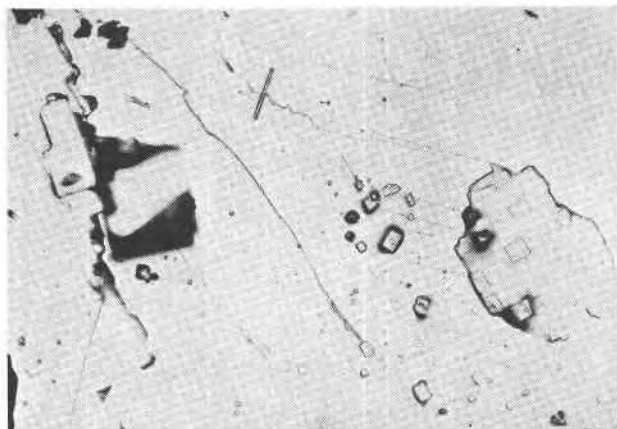


FIG. 4. Cleavage surface of Joplin galena, $\times 65$. This photograph plainly shows the sodium chloride cubes precipitating from brine. The liquid was derived from the complex negative crystal cavity.

In several fortunate instances, the actual brine was visually detected *in* the cavity exposed by cleavage. In such instances the cavity had the appearance of being full, but this is a fleeting observation which had to be made while the cavity was in the process of losing its liquid to the surrounding surface by reason of the spread of the liquid as a thin film. This liquid has a taste characteristic of a very concentrated brine. As it spreads to the surrounding cleavage its presence is usually indicated by the "oily" appearance of the cleavage surface due to interference of light in the thin film. The crystallization of the sodium chloride begins at once, and can be completely followed (See Figures 1, 2, and 4).

In most instances, after breaking a galena crystal the liquid has already spread or has been scattered by the mechanical jar of cleaving before one has a chance to view it in place. In all such cases, the "oily" appearance of the surface film or the occurrence of scattered brine drops is so patently associated with the cavity that no doubt can be entertained regarding the origin of the liquid. The crystallization can be watched as previously indicated, however.

The writer submits that the cases of halite occurring with galena described by Head are other instances of crystallization of brine from negative crystal cavities as above described. For those interested in the origin of the Mississippi lead-zinc deposits, it appears that an adequate sample of the solution present at the time of crystallization of the galena might be had in the following simple way: A relatively large lot of galena, known from preliminary breaking to be of the kind containing brine-bearing cavities, might be crushed under careful conditions and leached with a relatively small amount of water. After concentration, a thorough analysis of the water would give a set of data of incomparable value in the study of the origin of this type of deposit. From the nature of the negative crystal cavities, it appears certain that the contained solution would give a true sample of the solution which precipitated the galena, less whatever has been lost within the cavity by actual precipitation. Is it not possible that a search for filled voids in galena and other minerals from deposits of other than the Mississippi Valley type, will also furnish samples of the solution from which the crystals were deposited?

Dr. W. H. Newhouse has already instituted such search, with most gratifying positive results. These are detailed in a paper entitled "The composition of vein solutions as shown by liquid inclusions in minerals," which is about to appear in *Economic Geology*.