alkaline earths, and (b) high temperature conditions, though not so high as would necessitate the crystallization of the silicate of alumina as sillimanite. In general, staurolite is a high pressure mineral,[3] with pressure as a factor of greater significance than temperature, while garnet may form under a greater range of pressure and temperature conditions than either of the other two minerals. In contrast to garnet and staurolite, the stability of cyanite would appear to be here conditioned by proximity to igneous intrusion; for it is improbable that no sediments occur elsewhere in the series with similar high-alumina, high-silica, low-alkali content to that single band in which cyanite has been developed. The complete absence of sillimanite in a band of this composition would seem to be conclusive evidence that the temperature of formation of the metamorphic minerals was less than that which conditions the 'deep zone' of Grubenmann. The mineralization of the whole sedimentary series suggests rather a gradation from 'upper zone' temperatures, where not directly affected by igneous intrusion, to the 'middle zone' conditions where the intrusion of igneous batholiths raised the temperature of crystallization in the vicinity of the igneous bodies.

THE ORIGIN OF A NITER DEPOSIT NEAR DUBOIS, IDAHO[1]

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In the fall of 1922, while the writer was mapping the geology of the lava plain near Dubois, Idaho, his attention was called by Mr. Murray McWhorter to a deposit of a white crystalline salt in a cave in sec. 22, T. 11 N., R. 36 E. This salt was found to be practically pure potassium nitrate.

The niter sputters when ignited on charcoal, and under the microscope it is optically biaxial with a very small angle. The crystals vary in size, the maximum being about 1 millimeter in diameter. Analysis of a sample of the niter by Earl V. Shannon[2] gave the following results:

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[3] F. Becke, *Fortschr. d. Min. Kryst. u. Petr.*, **5**, 223, (1916).

[1] Published by permission of The Director, United States Geological Survey.

[2] Shannon, E. V., Nat. Museum, Washington, D. C.

ANALYSIS OF NITER DEPOSIT

CaO	None
KNO_3	98.74
$NaNO_3$	1.74
Cl, CO_2, SO_3	Traces
$Al_2O_3+Fe_2O_3$	Traces
H_2O below point of fusion	.12
Insoluble in water	.24

The cave in which the niter was found is located in a recent basalt flow and was caused by the doming of the crust of the flow by pressure while the lava was still viscous below. A small opening about 1½ feet in diameter on the west side of the pressure dome indicates the presence of the cave. The cave is about the size of a small room and is partially filled with wind-blown silt. The roof is composed of typical blue basalt from 1 to 5 feet thick, and is covered with small lava stalactites. It is these stalactites that indicate that the cave was formed by a doming of the crust while the interior of the flow was still liquid. The exterior surface of the roof is dusted over with one-half to 2 inches of wind-blown soil, and is broken by numerous joint cracks caused by the shrinking of the basalt as it cooled. Most of the cracks extend downward and are visible on the under side of the roof, especially where the stalactitic coating has scaled off. It was in these joint cracks, ⅛ to ¼ inch wide, and adhering to the roof adjacent to the cracks that the white crystals of niter were found. The niter was quite compact, and it was necessary to use a knife to scrape it off.

Mr. McWhorter reported that he had removed all the niter from the roof of the cave the previous year. As the writer had no trouble in collecting several ounces of it, the niter is evidently being deposited at the present time.

This fact led to a close examination of the conditions above the cave in order to determine its origin. The ground surface above the cave was covered with the excreta of sage hens, birds occurring in large numbers in the lava fields of southern Idaho. From this excreta bacterial action would develop nitrates. Percolating waters would carry the nitrates downward through the joint cracks and concentrate them on the roof of the cave by evaporation.

The accumulation of excreta on that particular spot is due to special conditions. The morning the writer visited the cave he noted that a flock of sage hens took flight from the area immediately over the cave where they had evidently been roosting overnight. The ground directly over the cave was bare although there was about 2 inches of snow on the ground elsewhere. The temperature inside the cave at the time was about 50°F., while the temperature outside was below freezing. Thus there was evidently sufficient heat radiating upward through the roof of the cave to keep the ground free of snow. This condition is known to prevail until late in winter. This snow-free spot being warmer than the neighboring area becomes a favorite roosting place for the sage hens during cold fall nights, and accounts for the amount of excreta found there. In short, the warmth of the ground above the cave makes this spot a favorite habitat for sage hens; excreta accumulates; bacterial action develops nitrates from it; percolating water carries the nitrates downward through joint cracks; and finally, evaporation concentrates them in the cracks and on the roof in the form of crystalline niter.

The thinness of the roof precludes the possibility of the potassium nitrate being leached from the basalt itself. Further, the fact that the niter is being deposited at the present time eliminates the chance of it having been formed from volcanic exhalations before the lava cooled.

In 1900, Hess[3] advanced the theory that niter deposits in caves were caused by percolating waters leaching the soluble salts from the soil above the cave and subsequently depositing it inside of the cave due to the evaporation of the water. With reference to this article, Nichols[4] stated that he believed the majority of niter deposits were formed from nearby guano deposits, but that Mr. Hess had pointed out a new method by which cavern deposits might be formed. Later, from numerous field observations, Gale[5] concluded that the majority of the cavern deposits of nitrates were derived from the decomposition of guano.

Because of the thinness of the soil overlying the cave near Dubois and because the topographic position of the cave makes it impossible for the water to come from nearby areas, it is evident that the deposit in this cave could not have been derived from soluble salts in the soil. The conditions of occurrence of this niter deposit seem to the writer conclusive evidence that at least this niter deposit was formed by the leaching of guano.

[3] Hess, W. H., "THE ORIGIN OF NITRATES IN CAVERN EARTHS." *Jour. of Geol.*, **8**, 129-134, (1900).

[4] Nichols, W. H., "NITRATES IN CAVE EARTHS." *Jour. of Geol.*, **9**, 236-243, (1901).

[5] Gale, H. S., "NITRATE DEPOSITS," *U. S. Geol. Survey, Bull.* **523**, 35, (1912).