SEDIMENTARY ANALCITE[1]

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In October, 1925, Mr. H. L. McCarn, a mining engineer of Chloride, Arizona, submitted a group of specimens to the United States Geological Survey for identification, and an examination indicated that part of the material was so unusual that a detailed study and report seemed to be justified.

The material resembles a fine grained, friable green sandstone. It was used as a building stone in some outbuildings at the Neal ranch across Sandy Creek from Wikieup post office, and came from a small gulch only a short distance from the banks of the Big Sandy on the Burro Creek road which crosses the Aquarius Cliffs in western Yavapai County, Arizona. Mr. McCarn states that these are sedimentary beds and were evidently Quaternary lake beds or playa deposits. The underlying material was a very fine grained, highly indurated greenish shale.

Microscopic examinations showed that the sandstone-like specimen is made up almost exclusively of small crystal grains. These range from 0.04 to 0.10 and average 0.06 of a millimeter in diameter, and a large proportion are perfect trapezohedrons; many are free individual crystals but others appear to be fused together into groups and irregular chains. Each grain is surrounded by a thin film of glauconitic material which gives it a greenish color. A slight banding effect is produced in the sandstone-like bed by differences in the proportion of the green film around the original grains and in the depth of the green color so produced. A fraction of 1 per cent of quartz, plagioclase and augite are the only other minerals present.

The optical properties are as follows: Isotropic; index of refraction 1.483; crystal form trapezohedron; specific gravity 2.26. The crystals contain cloudy inclusions that have a nearly concentric arrangement and probably represent opaline silica since the material is isotropic and the index of refraction is low. Crystals that have been approximately freed from the glauconitic coatings are a light gray green.

The following chemical analyses have been made of material that had been almost completely freed from the enclosing films of glauconite.

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Analyses: Analcite from Yavapai Co., Arizona

I

	Per cent.		Ratios	
SiO_2	60.61	1.005	{253	253 excess SiO_2
			752	400
Al_2O_3	18.03	0.176	176	94
Fe_2O_3	1.01	0.006	6	
FeO	Undet.			
MgO	0.05	0.001	1	
CaO	0.04	0.001	1	
Na_2O	10.98	0.177 }	188	100
K_2O	1.02	0.011 }		
H_2O-	0.34		{88	{88 excess H_2O
H_2O+	8.36	0.464	376	206
	100.44			

II

	Per cent.		Ratios	
SiO_2	58.8	.975	{275	275 excess SiO_2
			700	400
Al_2O_3	17.9	.175	175	100
Fe_2O_3	2.2	.014	14	
FeO	0.1	.001	1	
MgO	0.8	.020	20	
CaO	0.5	.009	9	
Na_2O	9.8	.158 }	174	100
K_2O	1.5	.016 }		
H_2O-			{127	127 excess H_2O
H_2O+	8.6	.477	350	200
	100.2			

In these analyses the ratio of Al_2O_3 to Na_2O+K_2O is approximately 1 to 1 as it should be for analcite. In analysis I there is an excess of 15.25 per cent. of SiO_2 and 1.59 of H_2O. In analysis II there is 19.6 per cent. excess of SiO_2 and 2.3 of H_2O. Fe_2O_3, FeO, MgO and CaO total about 1.0 per cent. of analysis I and 3.6 per cent. of analysis II and are probably derived largely from glauconite that was not entirely removed before analysis. The excess silica and part of the water are probably present as opal inclusions in the analcite.

Thus the crystal form, the optical properties and the chemical composition indicate that the crystals are analcite.

It is remarkable to find a rock in a sedimentary series that is composed almost exclusively of analcite. Mr. McCarn is undoubtedly correct in believing that it is part of a lake bottom or playa deposit. The method by which sedimentary analcite is formed presents an interesting problem. It seems evident that sodium salts which were concentrated in a playa lake were the initial cause of this formation of analcite. The reaction between sodium salts and feldspar has been suggested as the mode of formation, but a small amount of perfectly fresh plagioclase is associated with the analcite grains and so it is evident that feldspar was stable under the conditions that prevailed during the formation of analcite. Playa deposits often contain beds of exceedingly fine grained or colloidal clay and it is possible that reactions between colloidal, hydrous aluminum silicates and sodium salts may have produced analcite. On the other hand volcanic ash showers frequently deposited beds of glassy ash in these playa lakes. Material of this kind commonly alters to bentonite but in the presence of concentrated sodium salts it might form analcite. A small proportion of minerals similar to those found in volcanic ash are associated with analcite but these are smaller in amount than in most ash deposits. With the information at hand it is impossible to decide between these two possible modes of origin for this analcite, but the sedimentary character can not be doubted. It is formed in part from detrital sediments and in part from chemical elements that were held in solution. Its origin therefore is a combination of mechanical deposition and chemical precipitation.

Mr. W. H. Bradley,[2] of the United States Geological Survey, has just described a similar occurrence of analcite. In the summer of 1925 sandstone-like beds of euhedral analcite that reach a maximum diameter of two millimeters were found in the Green River formation of Utah, Colorado and Wyoming. Bradley says "Field and microscopic study of these two types of zeolite-bearing rocks indicate that both minerals (analcite and apophyllite) formed in place on the lake bottom (or when only shallowly buried in ooze) as a result of interactions between various salts dissolved in the lake water and the dissolution products of volcanic ash that fell into the ancient Green River lakes."

[2] Bradley, W. H.; Zeolite beds in the Green River formation: *Science*, vol. **67**, pp. 73, 74, 1928.