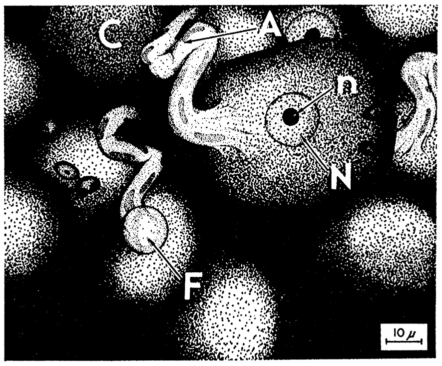

Fig. 4. Composite drawing based on many observations of unstained, unfixed frog dorsal root ganglion cells. *A*, axon; *C*, cell body; *F*, fat globule; *N*, nucleus; *n*, nucleolus.

frogs, the brains of anesthetized salamanders (*Triturus v. viridescens*) have been continuously observed for as long as 5 hours. Observations of the same salamander have been repeated after many days; nerve fibers in the optic tectum and cell bodies on the floor of the fourth ventricle were seen.

The loss of light within the current prototype of the new microscope was so great that, for observations of the living salamanders and of the freshly excised dorsal root ganglion cells, it was necessary to use the reflected image of the sun as the light source. The image formed at the eyepiece of the microscope generally included less than 0.001 percent of the light entering the microscope. When the sun was the light source, the amount of light that generally reached the cells was less than that of a conventional reflected-light microscope with a lamp having a tungsten-ribbon filament. This loss of light necessitated long exposures (1 to 4 seconds) for photography, so that the photographic image was degraded by vibrations in the microscope; current changes in design of the microscope should greatly reduce this loss.

With a new model of the microscope that is less wasteful of light, and with the objective fitted with a needle-like prism that can be inserted into nervous tissue (*4*), it may be possible to watch neurons during electrophysiologic experiments to see, for example, whether morphological changes accompany functional activity.

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Zeolitization of Tuffaceous Rocks of the Green River Formation, Wyoming

Abstract. *The alkali-rich zeolites mordenite and clinoptilolite have been discovered in tuffaceous rocks of the Green River Formation, Wyoming. This occurrence strongly supports the alteration of glass to alkali-rich zeolite to analcime as the paragenetic sequence of alteration of tuffaceous rocks deposited in ancient Lake Gosiute.*

Mordenite and clinoptilolite occur in tuffaceous rocks of the Tipton shale member of the Green River Formation. The analcime-rich tuffs of the formation have been known since the work of Bradley (*1*), but this is the first recorded occurrence of mordenite or clinoptilolite in the Green River Formation. Moreover, this occurrence strongly supports the suggestion of Hay (*2*) that analcime in tuffs of the Green River Formation formed by alteration of an alkali-rich zeolite precursor. Analcimic tuffs elsewhere in the Bridger Basin occur at the same stratigraphic interval in the Tipton shale member as do the mordenite and clinoptilolite-mordenite tuffs described in this report (*3*). The clinoptilolite-mordenite and mordenite-rich tuffs are characterized by relict vitroclastic textures, whereas the analcimic tuffs generally lack vitroclastic textures.

Characteristic x-ray diffractograms for mordenite and a clinoptilolite-mordenite mixture (Fig. 1) were obtained from two separate tuffs, both 0.1 to 0.3 feet (0.0305 to 0.0915 m) thick, in U.S. Bureau of Mines drill core 1-3, located in section 15, T18N, R10W, Sweetwater County, Wyoming. The drill core is 217.4 feet long and penetrates the lower part of the Wilkins Peak member, all of the Tipton shale member, and the top of the Wasatch Formation. The tops of the clinoptilolite-mordenite and mordenite-rich tuffs are, respectively, 87.9 and 90.4 feet above the base of the Tipton shale member. As by Bradley (*4*), the base of a coquina bed containing abundant *Goniobasis* sp. was used to designate the base of the Tipton shale member of the Green River Formation.

All of nine tuffs above the clinoptilolite-mordenite and mordenite-rich tuffs proved to be analcimic; the one below, montmorillonite-rich. The oil shales above the mordenite-rich tuff are analcimic also. The lowest analcimic oil shale in the drill core is directly above the mordenite-rich tuff; thus the transition from analcime to mordenite is very sharp.

Previously analcimic tuffs in the Green River Formation have been cited as an example of the reaction of saline lake waters with silicic volcanic glass to form analcime (*1*). However, Hay recently suggested that analcime can form at low temperatures by reaction

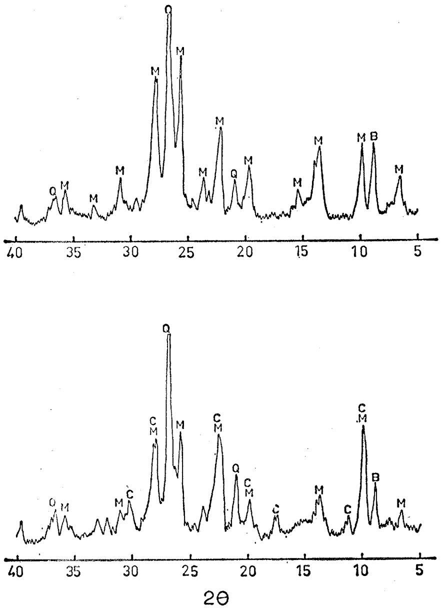

Fig. 1. Diffractometer patterns of mordenite-rich tuff (top) and clinoptilolite-mordenite tuff (bottom). Radiation is Cu*K*α (λ, 1.5418 Å). *M*, mordenite; *C*, clinoptilolite; *Q*, quartz; *B*, biotite.

of phillipsite, clinoptilolite, mordenite, erionite, and chabazite (*2*); furthermore he infers from studies of Quaternary saline-lake deposits that analcime in the Green River Formation formed by the reaction of alkali-rich zeolites. Only in this way can analcimic tuffs in the Green River Formation be reconciled with zeolitic tuffs of modern desert lakes, in which silicic glass alters directly to phillipsite, clinoptilolite, and erionite.

Petrographic study (*5*) of analcimic tuffs in the Miocene Barstow Formation of California has shown that analcime formed from clinoptilolite and phillipsite precursors instead of directly from silicic glass. Relict glass occurs in some tuffs of the Barstow Formation, but nowhere is analcime associated with the glass. Moreover, analcime probably has replaced phillipsite and clinoptilolite in the Miocene tuffs at Kramer, California (*2*). Thus it appears that analcime in saline-lake deposits characteristically forms from an alkali-rich zeolite precursor rather than by the direct reaction of saline-lake water with silicic volcanic glass.

In modern, saline, alkaline lakes a relation exists between salinity and zeolite reaction rates (*6*): in general, high salinity correlates with increased reaction rates. In addition, high salinity decreases the activity of water, possibly favoring a less hydrous phase such as analcime over more hydrous phases such as clinoptilolite or mordenite (*2*). The same relations hold true in the Green River Formation, where clinoptilolite and mordenite are preserved *only* in tuffs deposited in water that is relatively fresh.

Lake Gosiute, in which the Eocene Green River Formation was deposited, underwent several phases of expansion and contraction, possibly because of both climatic and tectonic changes (*7*). The Tipton shale member was deposited when the lake had great extent, whereas the overlying Wilkins Peak member was deposited when the lake was at its minimal extent. Extensive deposits of trona and other saline minerals in the Wilkins Peak member in Wyoming are well documented (*8*), but saline minerals are absent from the Tipton shale member. The high yields of oil by shales in the Tipton, higher than yields by the shales of Wilkins Peak, indicate relatively deep waters of moderate salinity. Organisms that thrived near the surface of the lake were preserved in the strongly reducing environment of a monimolimnion in the bottom layers of the lake water (see *9*).

Thus it is suggested that, in the relatively saline environment where the Wilkins Peak member was deposited, reaction rates were higher and the activity of water was lower, and tuffs containing clinoptilolite and mordenite reacted to form analcime; in the most saline environments, the analcime reacted to form albite or K-feldspar (*2*). In the less saline environment where the Tipton shale member was deposited, some of the tuffs containing clinoptilolite and mordenite have been preserved.

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High-Conductivity Solid Electrolytes: MAg_4I_5

Abstract. *The solid electrolytes* MAg_4I_5, *where M may be potassium, rubidium, or ammonium, have an ionic conductivity of 0.2 (ohm cm)*$^{-1}$ *at 20°C. Although pure* $CsAg_4I_5$ *does not form, partial substitution of cesium into the M position was obtained. The high-conducting phases of* KAg_4I_5 *and* $RbAg_4I_5$ *may be quenched to low temperatures, where they transform to resistive phases at —136° and —155°C, respectively.*

Solid electrolytes at ambient temperatures generally have extremely low ionic conductivities, less than 10^{-6} (ohm cm)$^{-1}$ whereas aqueous electrolytes have specific conductivities of nominally 0.5 (ohm cm)$^{-1}$. We were quite interested in the reports (*1*) that the compound Ag_3SI has a conductivity of 10^{-2} (ohm cm)$^{-1}$, and subsequently we have investigated a number of other double salts of AgI. We now report our electrical conductivity results for the compounds of the group MAg_4I_5 ($M = K$, Rb, NH_4, or, to a limited extent, Cs) in which we have observed conductivities of 0.21 (ohm cm)$^{-1}$ at 20°C.

An investigation of the alkali metal iodide–silver iodide systems has recently been carried out by Bradley and Greene (*2*). They also observed high ionic conductivity in MAg_4I_5, although the values of 0.05 and 0.12 (ohm cm)$^{-1}$ which they report for KAg_4I_5 and $RbAg_4I_5$, respectively, are somewhat lower than our result of 0.21 (ohm cm)$^{-1}$.

Bradley and Greene report conductivities for the temperature interval from room temperature to the incongruent melting points of KAg_4I_5 (253°C) and $RbAg_4I_5$ (228°C). Furthermore, these authors reported that conductivity was due entirely to silver ion. We investigated the conductivity of these compounds over the interval from $-165°$ to 150°C and found a reversible transition to a nonconductive phase occurring at low temperatures.

We prepared the MAg_4I_5 compounds by combining stoichiometric amounts of AgI and the alkali iodide, melting the mixture, and then quenching it. This intermediate product was ground,

Table 1. Low-temperature transition in solid electrolytes MAg_4I_5.

Compound	Transition temp. *T* (°C)	Specific conductivity (ohm cm)$^{-1}$ at *T*	
		α-Phase	β-Phase
KAg_4I_5	-136	5×10^{-4}	2×10^{-6}
$(K_3Rb)_{\frac{1}{4}}\,Ag_4I_5$	-139	2×10^{-4}	1×10^{-6}
$RbAg_4I_5$	-155	5×10^{-5}	6×10^{-7}

Table 2. Lattice constants (*a*), x-ray densities, and bulk densities of MAg_4I_5.

Formula	*a* (Å)	X-ray density (g/cm^3)	Bulk density (g/cm^3)
KAg_4I_5	11.13	5.32	
$K_{0.5}Rb_{0.5}Ag_4I_5$	11.19	5.35	
$NH_4Ag_4I_5$	11.19	5.14	
$RbAg_4I_5$	11.24	5.38	5.30
$K_{0.5}Cs_{0.5}Ag_4I_5$	11.25	5.37	