estimated by using the theory developed by Chylek and Coakley (*13*). The value of the imaginary index of refraction for the aerosol material was estimated to be $0.000 < n_i < 0.010$ by comparing monochromatic measurements of the zenith sky radiance with radiance values calculated for several values of assumed n_i. The value $n_i = 0.002$ employed in the heating and cooling calculations indicate that the aerosols cause a slight heating (averaged over the year) of the earth-atmosphere system in the polar regions of about 0.06°C (assuming radiative equilibrium and neglecting climatic feedback mechanisms) and a cooling in the low latitude zones of about 0.2°C. These figures are for the background aerosols, far from significant surface sources. If the tropospheric aerosols over the continents, and especially the aerosols over the deserts, were included, the low-latitude cooling would probably increase. Indeed, estimates of desert surface albedos and desert aerosol loads, based on turbidity measurements made in northern Kenya, suggest that additional cooling is likely to result from the continental aerosol sources.

These numerical calculations are somewhat tentative since they are based on a rough determination of the imaginary component of the index of refraction n_i. Additional information is needed on n_i. In the meantime, calculations for various possible values of n_i indicate that the major conclusions reached here always hold (heating at the poles, cooling near the equator), although the numerical values could change upward or downward within a factor of 2 or so, depending on the actual value of n_i.

The increased cooling caused by the presence of the aerosol column over the equatorial regions and the slight aerosol-induced polar heating decrease the heat contrast between pole and equator, and this will act to slightly alter the atmospheric circulation (compared to an aerosol-free atmosphere) and may lead to a net cooling in the polar regions due to decreased advective heat transport, especially during the polar night. Ultimately, to derive the actual climatic impact of the aerosols, one must incorporate the aerosol parameters into a climate model that takes account of the various climatic feedback mechanisms and infrared heating terms. Until this is done, it can be stated roughly that the aerosols act to slightly heat the polar regions and cool the equatorial regions.

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Metamict Mineral Alteration: An Implication for Radioactive Waste Disposal

Abstract. *Pervasive alteration is a common feature of metamict minerals. Previous studies of metamict niobium-tantalum-titanium oxides and electron microprobe analyses of altered areas in metamict yttrialite document the leaching of uranium, thorium, and rare earth elements. These data suggest that glasses may not provide a stable medium for radioactive waste disposal.*

A recurring theme in discussions of radioactive waste disposal is the possibility of immobilizing the radioactive wastes in a silicate or borate glass. The stability of such a glass over long periods of time (for example, more than 100 years) is an important consideration, and one that is difficult to evaluate from laboratory experiments of necessarily more restricted time periods. One possible method of evaluating the stability of such glasses is to examine metamict minerals for alteration effects.

Table 1. Electron microprobe analyses of unaltered and altered zones in metamict yttrialite from the Rode Ranch pegmatite, Central Mineral Region, Texas. The unaltered material was analyzed by B. Bruun and B. Jensen, Minerologisk Museum, Oslo (*9*). Values for the altered material are averages from 15 analyses by R.C.E. Abbreviation: ND, not determined.

Metal oxide	Unaltered	Altered
SiO_2	27.35	26.95
Fe_2O_3	2.64	3.02*
FeO	0.10	
MnO	1.68	1.64
MgO	0.05	0.05
CaO	0.89	1.64
U_2O_3	2.09	1.56
ThO_2	11.98	10.67
La_2O_3	0.30	0.25
CeO_2	1.33	1.28
Pr_2O_3	0.27	0.30
Nd_2O_3	2.30	2.10
Sm_2O_3	1.79	1.61
Gd_2O_3	3.11	3.05
Tb_2O_3	0.56	0.50
Dy_2O_3	3.78	3.64
Ho_2O_3	0.68	0.58
Er_2O_3	2.30	2.12
Tm_2O_3	0.43	0.32
Yb_2O_3	2.54	2.11
Lu_2O_3	1.13	1.10
Y_2O_3	29.14	28.21
H_2O	3.84	ND
Total	100.28	92.70

*Oxidation state not determined by microprobe analysis, calculated as Fe_2O_3.

Metamict minerals are naturally occurring materials that were once crystalline but, because of later effects, are now amorphous (*1*). Although the exact mechanism for the transition from crystalline to metamict state is poorly understood, radiation damage from constituent uranium and thorium nuclides must be critical to the process (*2*–*4*). Thus metamict minerals provide an ideal model for studying glasses that have suffered radiation damage over geologic periods of time.

The most detailed studies of alteration of metamict minerals have been of complex Nb-Ta-Ti oxides (*5, 6*). The alteration is of two types: (i) primary or hydrothermal and (ii) secondary or weathering. Previously reported electron microprobe analyses of eight AB_2O_6-type Nb-Ta-Ti oxides [A = rare earth element (REE), Fe^{2+}, Mn, Ca, Th, U, or Pb; B = Nb, Ta, Ti, or Fe^{3+}] document the effect of primary and secondary alteration (*6*). With primary alteration there is a consistent increase in Ca, generally a decrease in U and Th, a decrease in the REE, a slight decrease in B-site cations, and an increase in structural and absorbed water. Secondary alteration is similar but produces a decrease in Ca, an increased leaching of A-site cations, and a relative increase in B-site cations. Both types of alteration are pervasive and affect physical properties (for example, lowering the refractive index and specific gravity). In some cases sperulitic recrystallization is initiated (*7*).

Alteration effects in metamict silicates are less well documented, but examination of selected specimens in the collection of the U.S. National Museum of Natural History (formerly the National Museum) (yttrialite, USNM 85070 and USNM 3780; gadolinite, USNM 5102; and allanite, USNM 96970) suggests that the effects are equally pervasive. Autoradiographs reveal clear evidence of uranium and thorium leaching along the numerous microfractures that are common in metamict minerals.

Detailed electron microprobe analyses of an altered zone in yttrialite $[(Y,Th)_2Si_2O_7]$ from the Rode Ranch pegmatite in Texas are summarized in Table 1. The Rode Ranch pegmatite occurs in the Valley Springs gneiss of the Precambrian in the Central Mineral Region of Texas (*8*). The yttrialite is completely metamict and can only be identified by x-ray diffraction after recrystallization at 1000°C for 1 hour in air. The wet chemical and x-ray fluorescence analysis by Bruun and Jensen (*9*) was completed on unaltered hand-picked material. The unaltered areas of the yttrialite in a polished thin section were used as the electron microprobe standard for the analysis of altered zones. This allows direct comparison of the composition of the two zones. The results are similar to those noted for complex Nb-Ta-Ti oxides and indicate primary alteration. There is an increase in CaO and H_2O with a decrease in SiO_2, U_2O_3, ThO_2, and the REE's.

Although preliminary, the data suggest that a glass phase is susceptible to alteration and thus may be an inappropriate medium for radioactive waste disposal.

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Tropomyosin Binding to F-Actin Induced by Myosin Heads

Abstract. *Tropomyosin is a regulatory protein associated with F-actin in many actomyosin contractile systems. If in vitro conditions are such that tropomyosin binds only slightly to F-actin, then the addition of myosin heads can induce stoichiometric binding between them. This suggests that formation of rigor bonds between actin and myosin heads may cause some change in the actin, stabilizing the appropriate binding site for tropomyosin.*

Tropomyosin was first isolated from skeletal muscle in 1948 (*1*) and shown to have a regulatory function on the actin-activated myosin (actomyosin) Mg-dependent adenosine triphosphatase (Mg-ATPase) (E.C. 3.6.1.3; ATP phosphohydrolase) in 1964 (*2*). Tropomyosin is also found in vertebrate cardiac and smooth muscles and in invertebrate muscles (*3*). There is evidence (*4*) for the existence of regulatory proteins similar to muscle tropomyosin in nonmuscle cells such as human blood platelets, the myxomycete *Physarum polycephalum*, embryonic chick brain cells, growing neurons, skin fibroblasts, and epithelial cells.

At the present time two basic types of models for skeletal muscle regulation are being seriously considered. I now report evidence in support of the type of model in which the regulatory proteins tropomyosin and troponin control the actomyosin Mg-ATPase activity by changing either (i) the conformation of the F-actin monomers (*5, 6*), (ii) the charge distribution around them (*7*), or (iii) their relationship to each other in the polymer (*5*). The experiment is based on the earlier finding from this laboratory (*8*) that tropomyosin binds very poorly to F-actin in 30 m*M* KCl and less than 0.1 m*M* free Mg^{2+}. The two types of models make different predictions about the effect of myosin rigor bonds on this system.

For the type of model already described in which tropomyosin can increase the interaction between actin and myosin at low adenosine triphosphate (ATP) concentration by inducing a change in the actin, symmetry arguments predict that the binding of myosin to actin would induce the same change. This in turn would enhance the binding between tropomyosin and F-actin. This type of model thus predicts that the presence of myosin rigor bonds will induce binding between tropomyosin and F-actin when it otherwise would not occur.

In contrast to this type of model for muscle regulation is the steric blocking model (*9*) in which actomyosin Mg-ATPase inhibition during relaxation results from the position of tropomyosin rather than from changes in F-actin. In its inhibitory position tropomyosin simply covers the myosin-binding sites on the actin filament, thereby preventing actin activation of the myosin Mg-ATPase. This model is based on recent x-ray diffraction studies of contracting skeletal and smooth muscles (*9, 10*), but it should be pointed out that the data from these studies are actually compatible with either model type. An indication of a small mass redistribution led to the proposal that tropomyosin moves from a relaxation position to a contraction and rigor position when relaxed muscle is activated or allowed to go into rigor. When tropomyosin is in the contraction and rigor position, the filament is described as being turned on—this is biochemically analogous to an uninhibited actomyosin Mg-ATPase. From this perspective the terms relaxation position and inhibitory position are synonymous, and when tropomyosin occupies this position the filament is often described as being turned off. The x-ray diffraction data, however, provide no information about the mechanism by which the filament is turned off.

The steric blocking model (*9*) assumes that when relaxed muscles go into Ca^{2+}-free rigor, the myosin heads actually push the tropomyosin molecules from the relaxation to the contraction and rigor position. If this is correct, then adding myosin heads under rigor conditions to regulated actin filaments would be expected to reduce the binding of tropomyosin to F-actin by sterically blocking its more favorable binding position. This prediction is the opposite of that made by the former model type.

^{125}I-Labeled tropomyosin was used to measure the binding between tropomyosin and F-actin (*8*). The labeled tropomyosin and F-actin were mixed in centrifuge tubes at 25°C. The differences between the radioactivity of a sample of each solution before sedimentation and the radioactivity of a sample of the corresponding supernatant gave a measure of the amount of tropomyosin bound to the F-actin in the pellet. Binding experiments in the presence of rigor bonds were performed in the same manner, except that soluble proteolytic digestion products of myosin (myosin heads), which retain both actin binding sites and Mg-ATPase activity, were added to the