Reports

Uranyl Ion Coordination

Abstract. *With a noncomplexing anion such as perchlorate ion, the uranyl ion coordinates to five monodentate oxygen ligands. The relation of this observation to the work of Evans is discussed.*

The uranyl ion UO_2^{2+} is linear and triatomic; the uranium atom therein can coordinate with other ligands in the plane perpendicular to the axis formed by the three atoms. The variety of coordination figures observed for oxygen ligands has been pointed out by Evans (*1*) on the basis of crystal structure analyses of rather complicated solids.

He concludes that the plane-pentagon structure may be prevalent. Implicit in the conclusions of Evans is the prediction that the uranyl ion will coordinate to five monodentate oxygen ligands provided the anion present can form a stable lattice with the resultant complex cation.

In the course of a study (*2*) of the coordination numbers of nontransition metals, we have made some complexes of uranyl ion with sulfoxides. While our results do not provide conclusive information about the structures of the complexes, they do support indirectly the conclusions of Evans.

Table 1. Analytical data on some new complexes of uranyl salts.*

Element	Calculated (%)	Found (%)
	$[UO_2(TSO)_5](ClO_4)_2$	
C	22.43	22.19
H	3.77	3.97
S	14.99	16.10
	$[UO_2(DMSO)_5](ClO_4)_2$	
C	13.94	14.76
H	3.52	3.90
Cl	8.25	8.03
S	18.65	18.61
	$UO_2(TSO)_2(NO_3)_2$	
C	15.18	15.27
H	2.54	2.99
N	4.42	4.35
S	10.13	9.76

* Analyses by Schwarzkopf Microanalytical Labs.

With perchlorate as the anion (because of its general tendency to avoid coordination spheres), we made complexes with dimethyl-sulfoxide (DMSO) and thioxane oxide (TSO) as ligands. The analytical data are presented in Table 1. Both sulfoxide complexes contain five ligands as predicted. Although we cannot offer a complete structure proof, the infrared data indicate that the sulfoxide oxygen of each ligand is coordinated to the uranyl ion. Also, it would be a surprising coincidence if two such different sulfoxide ligands were in lattice positions other than attached to the uranyl ion. This conclusion is strengthened by the fact that uranyl perchlorate crystallizes as the pentahydrate (*3*).

The nitrate ion is known to form complexes with uranyl ion. Thus, the results in Table 1 for uranyl nitrate with TSO indicate that there are present only two sulfoxide ligands for each uranyl ion. Similar complexes have been observed with DMSO (*4*) and triethylphosphate (*5*); it seems fair to conclude that the sulfoxide complexes of uranyl nitrate have structures related to the triethylphosphate complex (*5*) in which nitrate ion acts as a bidentate ligand.

The fact that the sulfoxide complexes of uranyl perchlorate have the stoichiometry (and presumably structure) suggested by the work of Evans (*1*) is encouraging. Experimental work (*6*) on complexes of mercuric perchlorate has shown the occasionally predicted (but not observed) coordination number to the oxygen of six. It is now apparent from our study and from the work on mercury that dipolar oxygen ligands such as DMSO (*4*), TSO (*2*), tetrahydrothiophene oxide (*7*), pyridine-*N*-oxide (*8*) and others for which steric problems are minimal may be useful in establishing metal ion coordination numbers to oxygen.

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21 October 1963

Detrital Mineral Grains in Tektites

Abstract. *Abundant detrital crystalline mineral grains have been found in layered Muong Nong-type indochinite tektites from Nong Sapong, northeastern Thailand. These grains are an integral part of some tektite layers, and their presence furnishes strong presumptive evidence that indochinites, as well as other tektite groups in which layered specimens occur, formed from surficial earth materials.*

Most investigators now agree that tektites are the result of some kind of impact. The question is whether the impact took place here on earth, on the moon, or possibly on some other celestial body. If the impact took place on earth, tektites containing incompletely melted earth material should exist; but until now such material has not been found. Layered tektites of the Muong Nong type provided the logical place to search for included minerals because they show chemical and mineralogical evidence of having formed at lower temperatures than the normal sphere-, teardrop-, dumbbell-, and other splash-form types of tektites.

A petrographic microscopic examination of plates 1-m thick, cut from 15 specimens of layered indochinites from

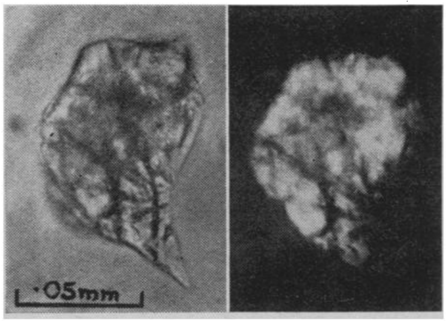

Fig. 1. (Left) Mineral grain in layered Muong Nong-type indochinite from Nong Sapong, Thailand, in plane-polarized light. (Right) The same mineral grain between crossed-nicols remains light, showing that it is crystalline. The streaks which remain dark between crossed nicol prisms may be fractures filled by isotropic glass.

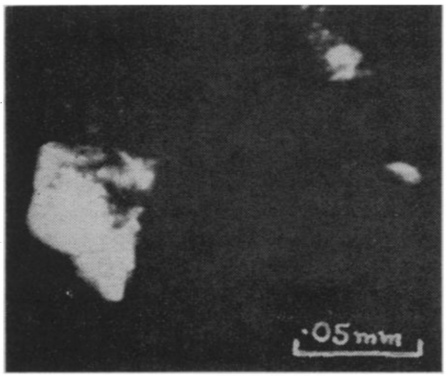

Fig. 2. Crystalline mineral grains in layered Muong Nong-type indochinite from Nong Sapong, Thailand, between crossed nicol prisms. The angularity of the larger grains shows that the melt was relatively cool when the grain was incorporated.

Nong Sapong, showed scarce to abundant detrital mineral grains in five of the plates (Fig. 1). Most of the mineral grains range in size between 0.01 and 0.1 mm. Several tested samples have birefringence and uniaxial-positive interference figures typical of quartz, and two grains isolated from crushed tektite have the refractive index of quartz. It is likely, therefore, that most of the included detrital mineral grains are quartz.

That the mineral grains were incorporated into the tektites when the melt was still very hot is apparent from their crackled appearance and hazy birefringence. The grains occur in bubbly layers rich in tiny lechatelierite particles and frothy lechatelierite (*1*), and these layers alternate with layers which are free of mineral grains and contain scant lechatelierite and bubbles. Thus the grains appear to have entered the melt while it was in the process of flowing, cooling, and becoming layered. The angularity of one of the larger grains (Fig. 2) indicates that at the time it was incorporated the melt had cooled below the point at which rounding of grain edges could take place.

Previously I described detrital mineral grains along faults in layered indochinites from Kan Luang Dong, Thailand, about 40 km south of Nong Sapong (*2*). These grains, as well as those included in tektite layers at Nong Sapong, are all the size of silt and finest sand. The country rock in the vicinity of these tektite localities is silty and sandy clay, and angular quartz grains up to 0.25 mm (rarely as much as 0.4 mm) are very abundant in the sandy clay and overlying soil. Such a correspondence in size and angularity between grains in layered tektites and grains in the material on which they lie strongly implies that layered tektites are locally derived.

By whatever manner the mineral grains of silt and fine-sand size were introduced along the faults, it is likely that dust of similar size was thrown into the air at the time of the faulting. If the dust settled on flowing melt it would have been incorporated, and the association of silica particles which had been subjected to different degrees of heating would thus be explained. The quartz particles which settled while the melt was hottest would have become lechatelierite, those which fell while the melt was at an intermediate temperature would have become frothy lechatelierite, and those particles incorporated after the temperature dropped below the melting point of quartz would have retained their crystallinity.

The supposed absence of transitional phases between tektites and earth materials has been considered as evidence against the terrestrial origin of tektites. This discovery of abundant detrital mineral grains in some layers of Muong Nong-type indochinites indicates the presence of this type of transitional phase (*3*).

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References and Notes

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4 November 1963

Neurospora Mutant Lacking an Arginine-Specific Carbamyl Phosphokinase

Abstract. *An arginine-requiring mutant of* Neurospora *lacks the carbamyl phosphokinase activity present in other strains. Although carbamyl phosphate, the product of this enzyme, is required in both arginine and pyrimidine synthesis, the enzyme appears to serve only the arginine pathway. A pyrimidine-specific mode of carbamyl phosphate synthesis is inferred, although it has not yet been demonstrated.*

Previous work in this and other laboratories (*1–3*) has indicated that some *Neurospora* mutants requiring arginine and others requiring pyrimidines are deficient in the synthesis of carbamyl phosphate (CAP), which is a precursor of both compounds. In the pathway of arginine synthesis, it is used in the carbamylation of ornithine to form citrulline, a reaction catalyzed by ornithine transcarbamylase (OTC). Early in the orotic-acid pathway of pyrimidine synthesis, it is used in the carbamylation of ornithine to form ureidosuccinate, a reaction catalyzed by aspartate transcarbamylase (ATC).

The mutants presumed to be deficient in carbamyl phosphate synthesis are the nonallelic *arg-2* (33442) and *arg-3* (30300) strains, and certain members of a series of allelic *pyr-3* mutants, represented by *pyr-3a* (37301) (*4*). The two arginine mutants grow on arginine or citrulline, but not on ornithine; this phenotype is not the consequence of an ornithine transcarbamylase deficiency. The *pyr-3a* mutant is blocked in the synthesis of ureidosuccinate, but has normal aspartate transcarbamylase activity (*5*). These observations suggest a pyrimidine-specific mode of carbamyl phosphate synthesis, under the control of the *pyr-3* gene, and an arginine-specific mode, under the control of the *arg-2* and *arg-3* genes (*1, 3*). Such a hypothesis is supported by studies of gene interaction. A strain carrying both *pyr-3a*, and a second mutation imposing an ornithine transcarbamylase deficiency, has no pyrimidine requirement (*1*). Similarly, strains carrying either *arg-2* or *arg-3*, plus a second mutation imposing an aspartate transcarbamylase deficiency, are relieved of their arginine requirement (*2, 6*). The data indicate that the specific source of carbamyl phos-