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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References

1. H. T. Evans, Jr., *Science* **141**, 154 (1963).
2. J. A. Stritar, thesis, Brown University (1962).
3. G. Gordon and H. Taube, *J. Inorg. Nucl. Chem.* **16**, 272 (1961).
4. F. A. Cotton and R. Francis, *J. Am. Chem. Soc.* **82**, 2986 (1960).
5. J. E. Fleming and H. Lynton, *Chem. Ind. London*, 1409 (1959).
6. R. L. Carlin, J. Roitman, M. Dankleff, J. O. Edwards, *Inorg. Chem.* **1**, 182 (1962).
7. R. Francis and F. A. Cotton, *J. Chem. Soc.* **1961**, 2078 (1961).
8. R. L. Carlin, *J. Am. Chem. Soc.* **83**, 3773 (1961).

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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