From: Lietai Yang
Sent: Friday, November 05, 2004 5:10 PM
To: Roberto Pabalan
Subject: Dust composition
Attachments: Atmospheric Dust Composition.doc

Bobby,

The following two tables are from the short write-up (enclosed). The reference should be citable.

-Lietai

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Source: National Atmospheric Deposition Program (NRSP-3)/National Trends Network. (2004). NADP Program Office, Illinois State Water Survey, 2204 Griffith Dr., Champaign, IL 61820, Website: http://nadp.sws.uiuc.edu Downloaded May 17, 2004.

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From: Lietai Yang

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"Roberto Pabalan" <rpabalan@cnwra.swri.edu>
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SUMMARY of ATMOSPHERIC DUST COMPOSITION AND ITS POTENTIAL EFFECT ON THE CORROSION OF WP AND DS

Lietai Yang
May 18, 2004

Background:

The Department of Energy has conducted analysis on the dust deposition and its impact on the corrosion of in Engineered Barrier Systems (BSC 2003a) However, the dust samples used in DOE salt analyses discussed in the technical basis document were collected in an exploratory study facility, where the majority portion was the rock dust produced during the construction of the tunnel (Peterman, 2003). During the ventilation period, a large portion of the dust on the WP and DS is expected to be consisted of the atmospheric dusts. This document presents the key components that are important to corrosion from the atmospheric dusts.

Data from USGS:

The United States Geological Survey (USGS) has a dust trap network consisting of about 40 sites in the southern California and Southern Nevada region. These dust traps were designed to study the rate of deposition, grain size, and mineralogical and chemical composition of dust. The dust traps collect not only mineral dust and aerosol, but also wet deposition such as rain and snow [Reheis, 2002]. Because of the object of the study, the analyses on the samples from these dust traps have been focused mainly on the metals in the raw and soluble-salt-removed dusts. Very few of the samples were analyzed for soluble salt constituents. Table 1 shows the composition of the key components analyzed from the dust samples collected at Owens Valley, California:

Table 1 Comparison of selected elements between processed (salts and organics removed), unprocessed, and soluble-fraction of dust samples collected at Owens Valley, California (Reheis, 2002).

Sample number	Sample Type	Fe	Ca	Na	K	Mg	Ba	Li	P	Pb	Rb	Sr	Zn
		wt%					Ppm						
T62-0595	proc.	2.8	7.3	2.9	3.6		1180				136	1070	4080
T62-0595	unproc.	2.4	5.1	2.1	9.2	2.6	1054	414	540	65	116	843	3240
T62-0595	salts	0	0.6	#	35	0	26	3	92	0	1	22	17
T62-1095	proc.	1.9	5.7	2.2	13		532				87	774	4250
T62-1095	salts	0	0.7	#	33	0	45	37	380	1	3	49	64
T-62-0599	unproc.	2.2	4.4	2	14	2.3	560	305	570	44	110	600	245

Detection limit exceeded by amount of element present.

Tables 1 shows that the main metals in the soluble salts are Na and K and the content of Ca is low (0.6 to 0.7 wt%). Most or all of the Ca, Mg and Fe are in the insoluble form. Table 1 also shows that the soluble salt contains considerable P.

Recently, a large number of the dust samples collected by Reheis at the USGS were analyzed by Izbicki et al (Personal communication, 2004) for anions in the soluble salts. Table 2 shows the average anion concentrations in the leachate of the atmospheric dusts collected in the southwestern United States region from winter 2001 to spring 2003 (ppm). The NO_3-to-Cl ratios were 1.63/0.75= 2.17 for the samples collected near the Yucca Mountain area and 3.11/3.62= 0.859 for the samples collected over the southern Nevada and California region. Significant amounts of other inhibiting specie, NO_2 and SO_4, were also found. In addition, Bromide and phosphate were significant. The effect of these two ions on the corrosion of drip shield and waste package outer layer should be assessed.

Table 2. The Average anion concentrations in the leachates of the atmospheric dusts collected in the southwestern United States region from winter 2001 to spring 2003

		N in N02	N in NO3	Cl	Br	P in PO4	SO4
Average of 36 Samples Collected near Yucca Mountain	ppm	16.38	22.80	26.67	29.43	2.38	73.59
	mM	1.17	1.63	0.75	0.37	0.077	0.77
Average of 89 Samples Collected in Southern California and Nevada	ppm	32.58	43.56	128.47	50.87	2.87	269.85
	mM	2.33	3.11	3.62	0.64	0.092	2.81

Source: Data were derived based on personal communication between Lietai Yang and John Izbicki, USGS Geochemical Laboratory, San Diego, April, 2004.

Data from the Atmospheric Deposition Monitoring Networks

The National Atmospheric Deposition Program/National Trends Network (NADP/NTN) operates a nationwide network of wet precipitation monitoring sites. The network is a cooperative effort between many different groups, including the State Agriculture Experiment Stations, U.S. Geological Survey, U.S. Department of Agriculture, and numerous other governmental and private entities. The NADP has over 200 monitoring sites in the continental United States, Alaska, Puerto Rica and the Virgin Islands. The NADA analyzes the constituents important to precipitation chemistry, including those affecting rainfall acidity and those that may have ecological effects. The NADP measures sulfate, nitrate, hydrogen ions, ammonia, chloride, and base cations (Ca, Mg, K).The sampling site at Death Valley, California may be considered the most relevant to the Yucca Mountain project because of its closeness to Yucca Mountain and the prevailing wind direction near Yucca Mountain area. The NADP system does not collect dry deposition samples.

The Clean Air Status and Trends Network (CASTNET), created by the U.S. Environmental Protection Agency and the National Oceanic Atmospheric Administration, provides atmospheric data on the dry deposition. The CASTNET data includes sulfate nitrate, ammonia, sulfur oxide, and nitric acid, and the meteorological conditions required for calculating dry deposition rates. The CASTNET operates about 70 sites across the United States, including one at Death Valley, California. Unfortunately, the CASTNET does not provide data on chloride and bromide.

Another network, the Atmospheric Integrated Monitoring Network (AIRMoN) provides atmospheric data on both dry and wet depositions with greater temporal resolution. The AIRMoN was sponsored by National Oceanic and Atmospheric Administration - Air Resources Laboratory to provide a research based foundation for the routine operations of the above-mentioned two deposition monitoring network- the NADP for wet deposition, and the CASTNET for dry deposition. The AIRMoN provides similar data as the NADP and CASTNET, except the samples are collected at a more frequent interval (daily). Currently, there are nine sites within the AIRMoN network. They are all located in the central and eastern parts of the Unites States. None of them are close to the Yucca Mountain area.

Table 3 shows summary of the NADP data for the precipitation samples collected at Death Valley, California in recent years. The samples from the NADP were filtered through 0.45 micron filters prior to analysis. Therefore, the data in Table 3 are considered as soluble ions. The three-year average NO_3-to-Cl ratio is 0.042/0.012 = 4.77 from the reported concentration measurements and 11.0/2.6 = 4.18 for the reported deposition amounts. The value of each constituent for the deposition amount was computed based on the concentration of the constituent in the wet precipitation and the amount of rainfalls. The two NO_3-to-Cl ratios should be the same. The small difference between the two ratios was probably due to errors in the computation of the source data.

Table 3 also shows that there were significant amount of Ca and Mg in the soluble salts collected from the wet precipitation. The molar concentration of Ca is close that of K and the molar concentration of Mg is twice as high as that of Na

Table 3, Summary of the soluble constituents in the wet precipitation samples collected at Death Valley, California in recent years

Concentration in Wet Precipitation									
Year	Mg	Ca	K	Na	NH4	NO3	Cl	SO4	pH
	mg/L								

2000	0.58	0.066	0.023	0.22	0.82	1.9	0.3	0.74	6.49
2001	0.18	0.019	0.022	0.097	0.69	1.51	0.15	0.53	5.46
2002	2.91	0.191	0.145	1.114	1.1	4.31	0.83	2.27	6.2
Average	1.223	0.092	0.063	0.477	0.870	2.573	0.427	1.180	6.050
	mM								
2000	0.024	0.002	0.001	0.010	0.051	0.031	0.008	0.008	
2001	0.007	0.000	0.001	0.004	0.043	0.024	0.004	0.006	
2002	0.120	0.005	0.004	0.048	0.069	0.070	0.023	0.024	
Average	0.050	0.002	0.002	0.021	0.054	0.042	0.012	0.012	
Deposition from Wet Precipitation									
	kg/ha								
Year	Mg	Ca	K	Na	NH4	NO3	Cl	SO4	
2000	0.26	0.029	0.01	0.098	0.37	0.85	0.13	0.33	
2001	0.11	0.011	0.013	0.058	0.41	0.9	0.09	0.32	
2002	0.2	0.013	0.01	0.078	0.08	0.3	0.06	0.16	
Average	0.190	0.018	0.011	0.078	0.287	0.683	0.093	0.270	
	mole/ha								
2000	10.700	0.725	0.256	4.261	23.125	13.710	3.667	3.434	
2001	4.527	0.275	0.332	2.522	25.625	14.516	2.539	3.330	
2002	8.230	0.325	0.256	3.391	5.000	4.839	1.693	1.665	
Average	7.819	0.442	0.281	3.391	17.917	11.022	2.633	2.810	

Source: National Atmospheric Deposition Program (NRSP-3)/National Trends Network. (2004). NADP Program Office, Illinois State Water Survey, 2204 Griffith Dr., Champaign, IL 61820, Website: http://nadp.sws.uiuc.edu Downloaded May 17, 2004.

Summary:

1. Limited data analyzed from two atmospheric dust samples collected near Yucca Mountain show that the soluble portion (soluble salts) of the dusts contains high concentration of Na and K, but low concentration of calcium and negligible amount of Mg.

2. The data analyzed from the atmospheric dusts collected near Yucca Mountain (36 samples) and in southern California and Nevada region (89 samples) indicate that the soluble portion of the dusts contains significant amount of corrosion inhibiting specie such as nitrate, sulfate and nitrite. The average ratio of nitrate-to-chloride is 2.17 near the Yucca Mountain area and 0.86 in the southern California and Nevada region.

3. The three year (2000 to 2002) data from the wet precipitation samples collected by the National Atmospheric Deposition Program at Death Valley, California also show high ratio of nitrate-to-chloride (4.2 to 4.8).

4. The three year (2000 to 2002) data from the wet precipitation samples also shows that there were significant amount of Ca and Mg in the soluble salts. The

molar content of Ca is close that of K and the molar content of Mg is twice as that of Na.

5. The data from the atmospheric dust collected near Yucca Mountain also shows that the soluble portion of the dust samples contain significant amount of bromide and phosphate.

References:

BSC, 2003a. "Technical Basis Document No. 5: In-Drift Chemical Environment." Rev. 1. Las Vegas, Nevada: Bechtel SAIC Company LLC. 2003.

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