

**International Workshop on  
Environmental Aspects of Coal Ash Utilization**

Tel Aviv, Israel  
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**Jisr-El-Zarqa Coal Ash Embankment - Summary of Ten Years**

**Monitoring**

*Y. Nathan<sup>1</sup>, Y. Deutsch<sup>1</sup>, R. Keren<sup>2</sup>, M. Benhur<sup>2</sup>, O. Yoffe<sup>1</sup>, A. Metzger<sup>3</sup>, M. Dvoracheck<sup>1</sup>*

<sup>1</sup>Geological Survey of Israel. <sup>2</sup>Volcani Institute. <sup>3</sup>Israel Electric Co.

**Abstract**

In 1997, it was decided to build a new access road of about 1.1 km in length to the village of Jisr el Zarka with a bridge over the Tel Aviv – Haifa highway. This was an opportunity to experiment with the use of coal ash as a structural fill in the road and in an embankment for the bridge. Some 28.000 tons of ash were used. Since, at that time, coal ash had never been used before for infrastructures in Israel, it was decided to conduct a long-term monitoring program, mainly to check the environmental consequences.

Two cores, of each about three meters long, were taken from the bridge embankment in Jisr in each of the years 2000, 2003, and 2006. All the selected ash samples taken from these cores were prepared for chemical analyses in two different manners. A lithium metaborate fusion dissolved in dilute HNO<sub>3</sub> was used for major element analyses; these were determined by inductive coupled plasma emission spectroscopy (ICP-AES). The trace elements and S were determined by ICP-MS (mass spectrometry) after sintering with sodium peroxide and dissolved in 5 M HCl. The mineralogy of the samples was carried out using X-ray diffractometry (XRD) and Fourier transform infra-red (FTIR) spectroscopy. The morphology and chemistry of single particles was studied by a scanning electron microscope (SEM) with a non-dispersive analytical attachment. Furthermore some of the samples were leached by the EPA Toxicity Characteristic Leaching Procedure (TCLP). The results were compared to the same analyses on the original ash. There were no significant differences between all the chemical analyses of the original samples and those of the samples taken after three, six and nine years from the embankment.

From the groundwater monitoring no difference was evident between the water samples which were taken from the test and from those of the reference boreholes. Furthermore, investigation of the permeability of the wet compressed fly ash, carried out during two winters showed that it is extremely low. No water was collected during these two years in containers at the bottom of the ash fill in the bridge embankment. These results show clearly that wet compressed fly ash is practically impermeable.

We endeavored to find out the reason and tried to find differences in the mineralogical analyses of dry and wet samples. The X-ray diffraction patterns showed a clear increase in calcite (CaCO<sub>3</sub>) and the disappearance of lime in the dry samples which

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contained lime. The SEM microphotographs showed a significant difference in the morphology. SEM microphotographs showed mainly pleospheres (Fig. 1), while in the wet samples; calcite particles (Figs. 2 and 7) and plates similar to phyllosilicates (Figs. 3 and 4) were clearly seen. This may be the explanation to the impermeability of the wet ash, and might be similar to what happens to wet clays. The chemistry of the plates showed that they are mainly Ca-Al-silicates (Fig. 5), in rare cases; they may be rich in Mg (Fig. 6) or iron. It is possible that these amorphous hydrated Ca-Al-silicates have similar cement properties (albeit weaker) to those of their crystalline counterparts.

There may be differences of opinion about the relative importance of the reactions which occur between fly ash and water and between fly ash and CO<sub>2</sub> in structural fills in road construction. Nevertheless, it is clear that in this use of fly ash, the mass of fly ash becomes practically impermeable and thus presents little danger to the environment. This poses a problem; what is the appropriate compliance test for this use of fly ash? The compliance test for leaching waste granular materials is obviously not applicable. The compliance test for waste monolithic materials appears to be more appropriate. This since generally, “monolithic waste” has been perceived as waste occurring in large blocks or large coherent masses of concrete-like material of substantial strength and very low permeability. It should nevertheless be taken into account that the composition of the leachate at the bottom of a typical monolithic landfill for most contaminants is likely to be controlled by equilibrium rather than by release rate.

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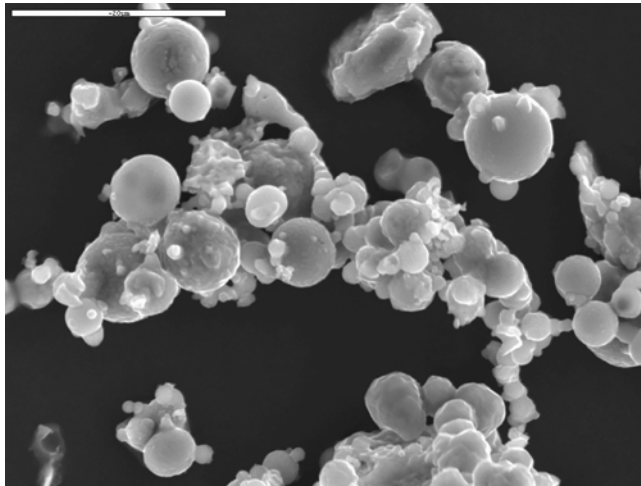


Figure 1 – SE microphotograph of dry ash.

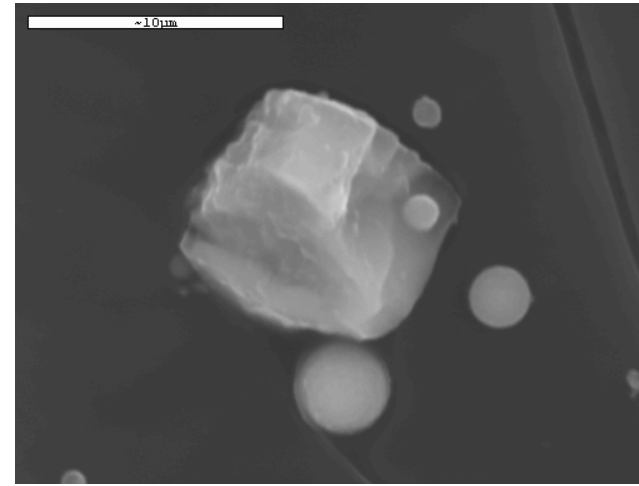


Figure 2 - SE microphotograph of a calcite crystal in wet ash.

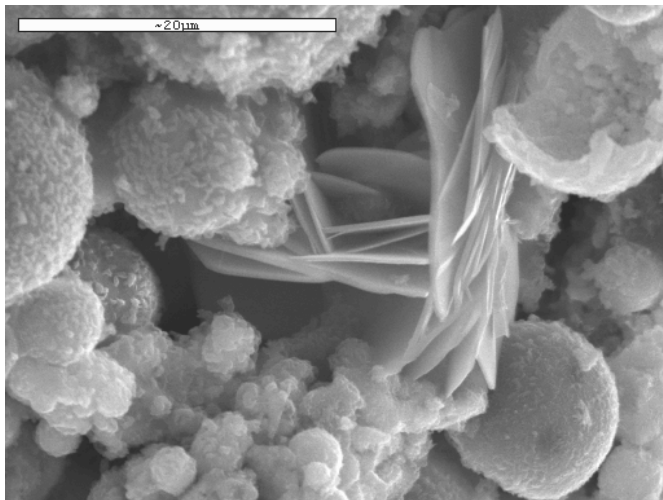


Figure 3 - SE microphotograph of wet ash showing platelets

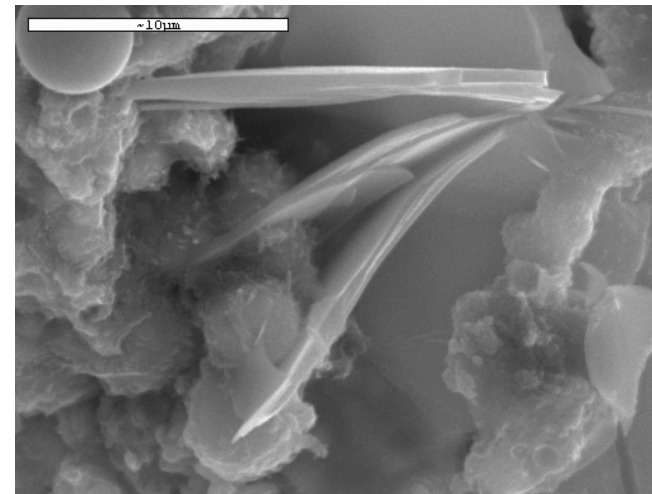


Figure 4 - SE microphotograph of wet ash showing platelets

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of amorphous Ca-Al-silicates.

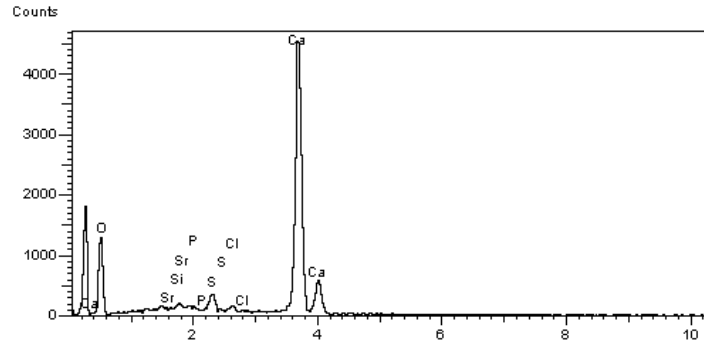


Fig. 5 – Non-dispersive chemical spectrum of the large particle (crystal?) in figure 2.

of amorphous Ca-Mg-Al-silicates.

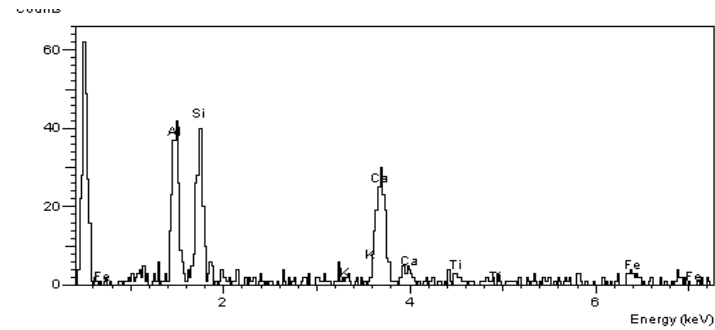


Figure 6 – Non-dispersive chemical spectrum of the platelets in figure 3.

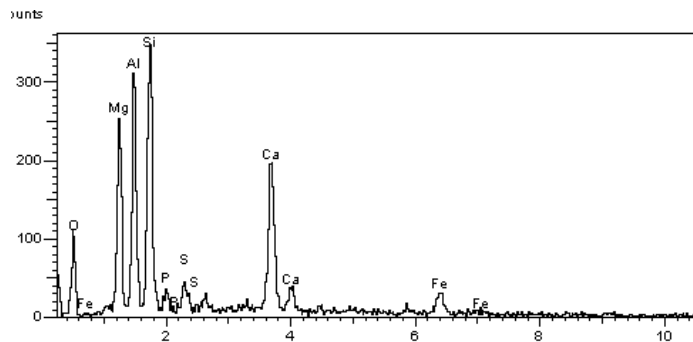


Figure 7 – Non-dispersive chemical spectrum of the platelets in figure 4.