HEAVY METAL TOXICITY AS A KILL MECHANISM IN IMPACT CAUSED MASS EXTINCTIONS: T.J. Wdowiak, Physics Dept., Univ. of Alabama at Birmingham, Birmingham AL 35294; S.A.Davenport, The Altamont School, Birmingham AL 35222; D.D.Jones, Dept. of Biology, Univ. of Alabama at Birmingham, Birmingham AL 35294; P.Wdowiak, 665 Pamela St., Birmingham AL 35213.

Heavy metals that are known to be toxic exist in carbonaceous chondrites at abundances considerably in excess to that of the terrestrial crust. An impactor of relatively undifferentiated cosmic matter would inject into the terrestrial environment large quantities of toxic elements (1). The abundances of toxic metals found in the Allende CV carbonaceous chondrite (2) and the ratio of meteoritic abundance to crustal abundance (3) are: Cr, 3630 PPM, 30X; Co, 662 PPM, 23X; Ni, 13300 PPM, 134X; Se, 8.2 PPM, 164X; Os, 0.828 PPM, 166X. The resulting areal density for global dispersal of impactor derived heavy metals and their dilution with terrestrial ejecta are important factors in the determination of the significance of impactor heavy metal toxicity as a kill mechanism in impact caused mass extinctions. A 10 km diameter asteroid having a density of 3 gram per cubic cm would yield a global areal density of impact dispersed chondritic material of 3 kg per square meter. The present areal density of living matter on the terrestrial land surface is 1 kg per square meter (4). Dilution of impactor material with terrestrial ejecta is determined by energetics, with the mass of ejecta estimated to be in the range of 10 to 100 times that of the mass of the impactor (5). Because a pelagic impact would be the most likely case, the result would be a heavy metal rainout. In the situation of nickel which is known to be toxic to plant life at concentrations of 40 PPM, the rainout of Ni would be in the 130 to 1300 PPM range. Nickel induces a deficiency in Fe which is required for chlorophyll synthesis, resulting in chlorosis (6). Experiments with Raphanus sativus (radish) seeds suggest germination would be particularly susceptible to Ni toxicity (1). In the case of a 10 km impactor of Allende meteorite composition the global areal density of meteoritic Ni would be 40 gram per square meter.

The formation of nitrogen oxides in the fireball with subsequent nitric acid rainout has been suggested as a kill mechanism for impact caused mass extinctions (7). Meteoric nitric acid would convert heavy metal oxides that are the prompt chemical species in the fireball into highly soluble nitrates which are the most toxic form of heavy metals (8). The combination of a nitric acid / heavy metal rainout as a prompt kill mechanism of plant life and heavy metal contamination of top soil as an agent that prevents re-establishment of plant life for an extended period is an attractive combination for explaining impact caused mass extinctions. Large scale desertification is a likely result including a change in albedo leading to climatic change.

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References: (1) Davenport,S.A., Wdowiak,T.J., Jones,D.D., and Wdowiak,P. (1988) submitted to Nature.; (2) Kallemeyer,G.W. and Wasson,J.T. (1981) Geochim. cosmochim Acta V.45, 1217.; (3) Smith,D.G., ed.(1981) The Cambridge Encyclopedia of Earth Sciences, 60 (Cambridge Univ. Press).; (4) West,R.C., ed. (1978) Handbook of Chemistry and Physics, F-197 (CRC Press).; (5) O'Keefe,J.D. and Ahrens,T.J. (1982) in Geological Implications of Impacts of Large Asteroids and Comets on the Earth (ed. Silver,L.T. and Schultz,P.H.) 103 (Geological Society of America).; (6) Treshow,M. (1970) Environment and Plant Response, 191 (McGraw-Hill).; (7) Lewis,J.S., Watkins,G.H., Hartman,H., and Prinn,R.G. (1982) in Geological Implications of Impacts of Large Asteroids and Comets on the Earth (ed. Silver,L.T. and Schultz,P.H.) 215 (Geological Society of America).

Table 1. Abundance of selected elements in the terrestrial crust (3), the Allende CV carboaceous chondrite (2), and their ratio indicating excessive abundance of Cr,Co,Ni,Se,Ru,Os,Ir, and Au in the meteorite relative to the terrestrial crust (from ref. 1).

	Crust Terrestrial (PPM)	Allende (PPM)	Allende /Terrestrial
Na	22700.	3290.	0.145
Mg	27640.	148000.	5.35
Al	83600.	17600.	0.21
K	18400.	294.	0.016
Ca	46600.	18800.	0.40
Sc	25.	11.3	0.45
V	136.	99.	0.73
Cr	122.	3630.	29.75
Mn	1060.	1450.	1.37
Fe	62200.	237000.	3.81
Co	29.	662.	22.83
Ni	99.	13300.	134.
Zn	76.	119.	1.565
Ga	19.	6.0	0.316
Ge	1.5	16.2	10.8
As	1.8	1.55	0.86
Se	0.05	8.2	164.
Br	2.5	1.6	0.64
Ru	-	1.150	-
Cd	0.16	0.436	2.725
In	0.24	0.035	0.146
Sb	0.2	0.083	0.415
La	34.6	0.49	0.0142
Sm	7.0	0.298	0.0426
Eu	2.1	0.113	0.0538
Yb	3.1	0.320	0.103
Lu	-	0.46	-
Os	0.005	0.828	165.6
Ir	0.001	0.785	785.
Au	0.002	0.145	72.5