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Concerning mercury in meteorites

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ABSTRACT

The mercury concentration of all analyzed meteorites (falls) shows an increasing trend with their terrestrial age. Such a trend, in view of the intense Hg pollution of the earth, warrants careful selection of well preserved and well documented specimens for analysis.

THE importance of mercury abundances in meteorites in understanding the conditions of formation of solar system as well as the meteorites is well known (Larimer and Anders 1967, Arrhenius and Alfven 1971). These abundances show a wide scatter even for samples of the same meteorite which is difficult to understand. Bearing this in mind and also the recent realization of intense mercury pollution of our planet (Klein and Goldberg 1970, Joensuu 1971, Foote 1972), an attempt is made to see the kind of effect terrestrial contamination would have on the natural levels of mercury in meteorites.

We consider only the measurements in falls and those made using the neutron activation method. In table 1 is given the name of each meteorite, its class (Mason 1962, Van Schumus and Wood 1967), date of fall (Hey 1966), and its total mercury concentration (Reed and Jovanovic 1967, Kiesl *et al.* 1967, Ehmann and Lovering 1967, Tanner 1968). The data are given for meteorites separately for the three groups, chondrites, achondrites and irons—the usual classification for stones is also given (table 1). For each class of meteorites, the mercury concentration is plotted as a function of the year of fall of the meteorite (figure 1). It seems significant that in general, irrespective of the class of meteorite, the mercury concentrations show an overall increase with increasing terrestrial age despite the scatter. Of the twenty-four analyzed irons only two are falls; rest were found between 1576 and 1942 and are low in mercury by about one order of magnitude compared to the stones (table 1); the concentration levels are similar to those corresponding to amounts of Hg released at temperatures $>450°$ C in chondrites (Reed and Jovanovic 1967).

Table 1. Mercury concentration of meteorites*

Meteorite (5)	Class (6)	Date of fall (7)	Total Hg concentration in ppm (8)	(9)	(10)	(11)
Chondrites						
Canakkale	——	End–7–1964	0·11			
Peace River	Hypersthene	31– 3–1963	0·02		0·03	
Harleton	,,	30– 5–1961	0·44		0·16	
Ehole	——	31– 8–1961	0·27			
Bruderheim	Hypersthene	4– 3–1960	0·044		0·06	
Breitscheid	——	11– 8–1956	4·0			
Abee	Enstatite	10– 6–1962	1·4	0·2	1·52	
Murray	Carbonaceous	20– 9–1950			1·57	
Monze	Hypersthene	5–10–1950	0·82			
Kunashak	,,	11– 6–1949	1·19			
Krymka	,,	9– 6–1946	0·02			
Hallingeberg	,,	1– 2–1944	0·46			
Pantar	Bronzite	16– 6–1938	0·5			
Ivuna	Carbonaceous	16–12–1938	4·96			
Karoonda	,,	25–11–1930	0·8		1·28	
Beardsley	Bronzite	15–10–1929			0·08	
Rose City	——	17–10–1921	4·10			
Richardton	Bronzite	30– 6–1918	1·60		0·36	
Colby Wis	Hypersthene	4– 7–1912	1·32			
Holbrook	,,	19– 7–1912	0·44	1·8	0·17	
Vigarano	Carbonaceous	22– 1–1910		2·43		
Mokoia	,,	26–11–1908			4·0	
Sindhri	Bronzite	10– 6–1901	5·84			
Hvittis	Enstatite	21–10–1901	0·80		0·72	
Bjurbole	Hypersthene	12– 3–1899	2·87			
Indarch	Enstatite	7– 4–1891	0·16			
Forest City	Bronzite	2– 5–1890	0·26		0·08	
Farmington	Hypersthene	25– 6–1890	0·049			
Mighei	Carbonaceous	18– 6–1889	4·9		6·82	

TABLE I—(*Contd.*)

Meteorite	Class	Date of fall	Total Hg concentration in ppm			
(5)	(6)	(7)	(8)	(9)	(10)	(11)
Mocs	Hypersthene	3– 2–1882	0·92	8·8		
Tieschitz	——	15– 7–1878	7·22			
Sokobanya	Amphoterite	13–10–1877	0·84	4·7		
Lance	Carbonaceous	23– 7–1872	1·6			
Pultusk	Bronzite	30– 1–1868	7·45			
Knyahinya	Hypersthene	9– 6–1866		3·8		
Orgueil	Carbonaceous	14– 5–1864			20†	
Grosnaja	..	28– 6–1861	4·81			
New Concord	Hypersthene	1– 5–1860	0·89			
Achondrites						
Norton Co.	Aubrite	18– 2–1948			0·054	
Ellemeet	Diogenite	28– 8–1925			0·43	
Johnstown	,,	6– 7–1924			0·12	
Serra de Mage	Eucrite	1–10–1923			0·21	
Moore County	Eucrite	21– 4–1913			2·74	
Nakhla	Nakhlite	28– 6–1911			0·23	
Juvinas	Eucrite	15– 6–1821			5·01	
Stannern	,,	22– 5–1808		0·3	9·12	
Irons						
Bogou		14– 8–1962				0·06
Sikhote-Alin		12– 2–1947				0·04
Edmonton		Found 1942				0·31
Soper		Found 1938				1·25
Henbury		Found 1931				0·50
Grant		Found 1929				0·10
Odessa		Found 1922				0·25
Cedartown		Found 1898				0·07
Sacramento Mountains		Found 1896				0·09
Arispe		Found 1896				0·33
Dayton		Found 1892–93				0·05
Canyon Diablo		Found 1891				0·20
Kenton County		Found 1889		0·03		
San Cristobal		Found 1882		0·13		

TABLE I—(*Contd.*)

Meteorite	Class	Date of fall	Total Hg concentration in ppm			
(5)	(6)	(7)	(8)	(9)	(10)	(11)
Tombigbee		Found 1859				0·21
Trenton		Found 1858				0·04
Central		Found 1855				0·15
Arva Magura		Found 1840		0·14		
Gibson		Found before 1836				0·12
Coahulia		Found 1837				0·06
Toluca		Found 1776				0·05
Campo del Cielo		Found 1576				0·26

* Determined by neutron activation analysis only. The errors in measurement are 10–15% or less.

(5) Mason 1962.

(6) Van Schmus and Wood 1967.

(7) Hey 1966.

(8) Reed and Jovanovic 1967.

(9) Kiesl *et al* 1967.

(10) Ehmann and Lovering 1967.

(11) Tanner 1968.

— Refers to chondrites not classified by Van Schmus and Wood (1967).

† Eight measurements ranging from 2·4–213 ppm exist for Orgueill, five of which cluster around 20 (8, 10): a mean Hg content of 20 ppm is taken for this meteorite.

One point deserves special mention in this regard: All analyzed carbonaceous chondrites (C_1-C_3), which are the most porous of all meteorites have in general high Hg concentrations. One of the most porous carbonaceous chondrites, Orgueil has in fact the highest Hg content so far measured (213—Reed and Jovanovic 1967, Ehmann and Lovering 1967). In contrast, the irons which are most compact have the lowest Hg contents, 0·04–0·5 ppm except for Soper which has 1·25 ppm (table 1).

It is well known that each meteorite has not fallen right into a clean polyethylene bag; it has been moved around through several hands and places before ending up in the quartz vial for neutron activation. It is also possible that some meteorites would have fallen in mercury polluted areas and others in relatively cleaner places. Unfortunately it is not possible to ascertain this aspect in view of the several stories associated with each specimen, particularly in the case of older ones, quite a few of which show high mercury concentrations (table 1). Museums particularly may not be safe abodes for meteorites from the Hg point of view. Laboratory experiments of several weeks' duration were carried out to study contamination in meteorites by placing them near Hg diffusion pumps, near a bowl of mercury, etc. (Reed and Jovanovic 1967). These experiments, however, did not rule out contamination in all cases studied. In this connection, it is interesting to add that lunar samples which were brought to our planet in clean containers appear to be very clean in respect of Hg (0·6 to 41 ppb—Reed and Jovanovic 1970; Reed *et al.* 1972).

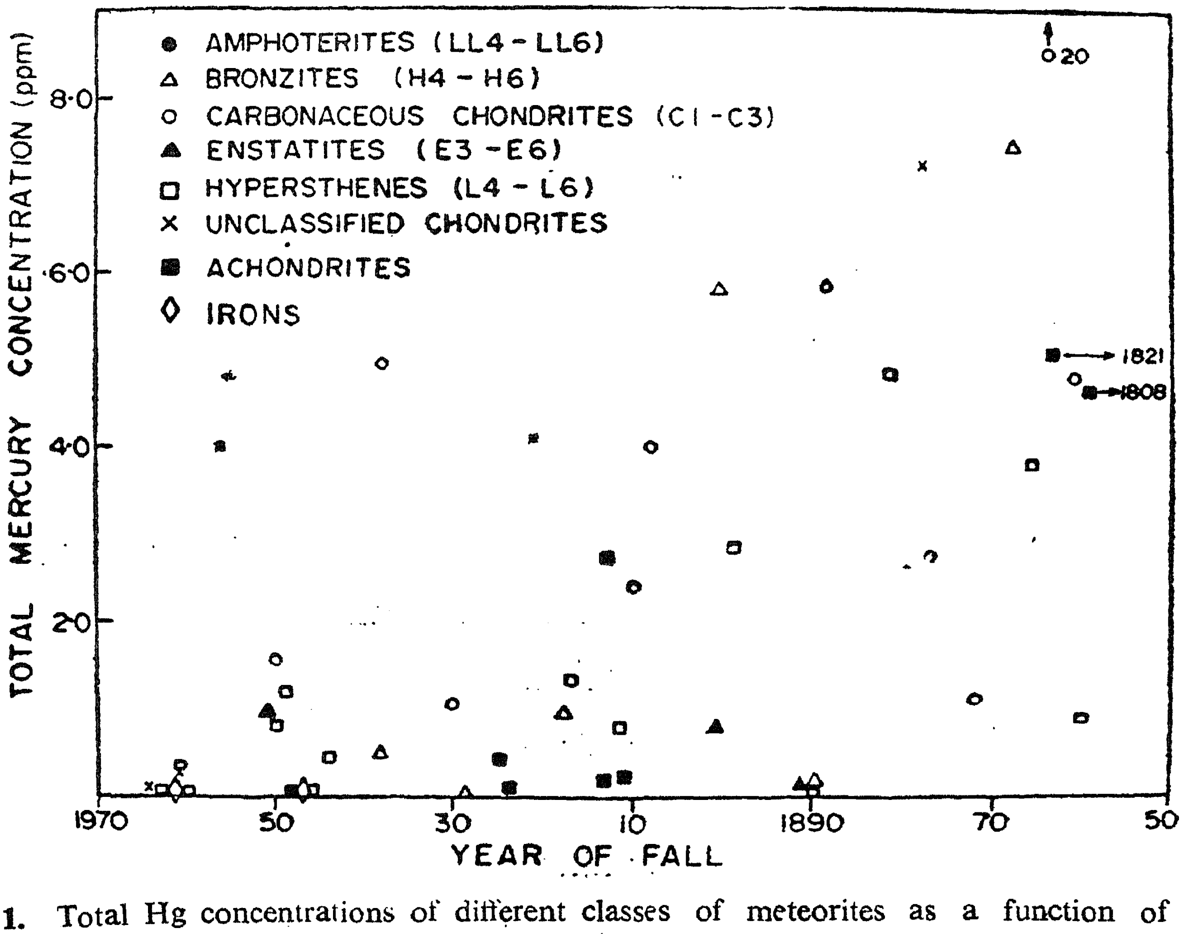

Figure 1. Total Hg concentrations of different classes of meteorites as a function of their year of fall. For meteorites with more than one measurement a mean value is taken; for Orgueil a mean value of 20 is indicated. See text and the footnotes of table 1 for further details.

It is clear from the analysis presented here that contamination alone is not the case; one notes cases of older meteorites too with low Hg concentrations (table 1, figure 1). The above arguments are all meant only to caution the cosmochemist to select proper samples well preserved and well documented for Hg determinations.

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