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Mineralizing fluids for hydrothermal gold deposits through Earth history

Prokofiev, V.Yu.[1], Naumov, V.B.[2] and Mironova, O.F.[2]

[1] Institute of Geology of Ore Deposits, Petrography, Mineralogy, and Geochemistry, Russian Academy of Sciences, Staromonetnyi per. 35, Moscow, 119017 Russia, vpr2004@rambler.ru.
[2] Vernadsky Institute of Geochemistry and Analytical Chemistry, Russian Academy of Sciences, Kosygina st., 19, Moscow, 119991 Russia.

The published data on the physicochemical parameters and chemical composition of the hydrothermal mineralizing fluids forming gold deposits were compiled and analyzed in terms of the geological history of Earth. The compilation included 5571 pieces of data for 360 gold deposits of various ages, from different regions of the Earth and from various gold deposit types including orogenic, epithermal, porphyry, Carlin-like, intrusion-related, and IOCG. Mean values of parameters and ranges of variation are shown in Table 1. The general trends in the changes of physicochemical parameters and the chemical composition of the mineral-forming fluids over Earth history are revealed. These are partly indicative of increasing levels of erosion of hydrothermal systems with increasing age, which is consistent with the conclusions from other studies [1]. It is noted that there is an increase in the average ore-forming fluid pressure from the Cenozoic deposits back to the Proterozoic ones, with an absence of low-pressure fluids in the Precambrian deposits and a prevalence of lower pressures in younger goldfields.

Table 1. The average and range of physicochemical parameters of gold-bearing ore-forming fluids of various geological ages.

Age, Ma	Temperature, ºC	Pressure, bar	Salinity wt. %-eqv. NaCl	Percent with low-salinity fluids (<5 wt% NaCl equiv.)	n
Cenozoic (<65)					
257 (50-610)	979 (20-3600)	8.5 (0.01-59.0)	62.4	1233	
Mesozoic (235-65)					
281 (80-957)	1079 (30-3700)				

	14.2 (0.1-82.0)
	31.3
	2158
Paleozoic (540-235)	
	262 (48-600)
	1278 (4-3500)
	10.1 (0.1-66.8)
	38.7
	895
Proterozoic (2500-540)	
	231 (48-615)
	2008 (120-6500)
	14.2 (0.1-68.0)
	31.3
	954
Archean (3200-2500)	
	252 (50-570)
	1744 (330-6400)
	10.9 (0.1-63.0)
	36.0
	331

n = number of samples.

However, not all the differences can be explained by an increase in the formation depth of the deposit. Higher fluid pressure and gas content characterize ore-forming fluids of the Proterozoic compared with the older Archean crustal fluids. Furthermore, the gas component of the Archean gold deposits is enriched with methane, whereas the Proterozoic ones are enriched with nitrogen. Possibly nitrogen entered the atmosphere from the deep layers of the Earth, carried by endogenous fluids. This is consistent with the data from carbon isotope studies of fluid inclusions in quartz for Archean and Proterozoic gold deposits in Africa. These studies have shown the presence of different geochemical reservoirs of carbon dioxide for the Archean versus the Proterozoic ore-forming systems in Africa [2].

The detected patterns for the chemical composition and the physiochemical parameters of the gold-bearing ore-forming fluids over Earth history require further detailed study. This should involve a significantly larger data set for understanding the evolution of endogenous fluids over time.

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