



Plutonium age dating reloaded

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Although the age determination of plutonium is and has been a pillar of nuclear forensic investigations for many years, additional research in the field of plutonium age dating is still needed and leads to new insights as the present work shows: Plutonium is commonly dated with the help of the $^{241}\text{Pu}/^{241}\text{Am}$ chronometer using gamma spectrometry; in fewer cases the $^{240}\text{Pu}/^{236}\text{U}$ chronometer has been used. The age dating results of the $^{239}\text{Pu}/^{235}\text{U}$ chronometer and the $^{238}\text{Pu}/^{234}\text{U}$ chronometer are scarcely applied in addition to the $^{240}\text{Pu}/^{236}\text{U}$ chronometer, although their results can be obtained simultaneously from the same mass spectrometric experiments as the age dating result of latter. The reliability of the result can be tested when the results of different chronometers are compared. The $^{242}\text{Pu}/^{238}\text{U}$ chronometer is normally not evaluated at all due to its sensitivity to contamination with natural uranium. This apparent 'weakness' that renders the age dating results of the $^{242}\text{Pu}/^{238}\text{U}$ chronometer almost useless for nuclear forensic investigations, however turns out to be an advantage looked at from another perspective: the $^{242}\text{Pu}/^{238}\text{U}$ chronometer can be utilized as an indicator for uranium contamination of plutonium samples and even help to identify the nature of this contamination. To illustrate this the age dating results of all four Pu/U clocks mentioned above are discussed for one plutonium sample (NBS 946) that shows no signs of uranium contamination and for three additional plutonium samples. In case the $^{242}\text{Pu}/^{238}\text{U}$ chronometer results in an older 'age' than the other Pu/U chronometers, contamination with either a small amount of enriched or with natural or depleted uranium is for example possible. If the age dating result of the $^{239}\text{Pu}/^{235}\text{U}$ chronometer is also influenced the nature of the contamination can be identified; enriched uranium is in this latter case a likely cause for the mismatch of the age dating results of the Pu/U chronometers.