Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.29817

Towards more reliable Rb-Sr geochemistry: standardization, reference materials, and uncertainty assessment

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The $^{87}Sr/^{86}Sr$ isotope ratio is a crucial tool for deciphering Earth's history, yet its application in microanalytical Rb-Sr dating faces persistent challenges. Despite decades of routine use of MC-ICP-MS and MC-TIMS, accuracy remains hindered by the lack of realistic reference materials and standardized measurement protocols.

This study underscores the need for reference materials that reflect real-world complexities, including diverse matrices, high $^{87}Sr/^{86}Sr$ ratios (> 0.8), and variable Rb/Sr ratios. Recent findings [1] demonstrate that both MC-ICP-MS and MC-TIMS can yield accurate results when applied correctly, ensuring measurement reliability. Additionally, we highlight the importance of realistic uncertainty estimates in Rb-Sr geochemistry, as current practices often underestimate true data variability.

To discuss the current situation, we present data for four cement reference materials [1], including the IAG GeoPT sample OPC-1, an IAG slate certified for major and trace elements (OU-6), and an Archean pegmatite (OU-9) [2] with unusual isotope and Rb/Sr ratios. Their potential applications and limitations are discussed.

There is a significant difference in the isotope ratio and the associated uncertainty between an absolute $n(^{87}Sr)/n(^{86}Sr)$ and a conventional $^{87}Sr/^{86}Sr$ isotope ratio. Where absolute $n(^{87}Sr)/n(^{86}Sr)$ isotope ratios are directly traceable to the primary reference material, conventional $^{87}Sr/^{86}Sr$ isotope ratios are traceable to a measurement and evaluation routine. Therefore, absolute $n(^{87}Sr)/n(^{86}Sr)$ and conventional $^{87}Sr/^{86}Sr$ isotope ratios are not fully comparable with each other.

Finally, we emphasize the need for harmonized data reporting within the radiogenic isotope community to improve data consistency and comparability across laboratories. Addressing these challenges will unlock the full potential of Rb-Sr geochemistry, leading to a more robust and reliable understanding of Earth's dynamic history.

[1] Kazlagić et al. (2023), *Geostand. Geoanalytical Res.* 47, 821–840.

[2] Chu, Z.-Y. et al. (2025), *Geostand. Geoanalytical Res.,* in production.