# Exposed Pleistocene Kurobegawa Granite (0.8 Ma): LA-ICP-MS and SHRIMP analysis

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A young exposed pluton represents the recent tectonic uplift and high exhumation because a pluton is a body of intrusive igneous rock that crystallized from slowly cooling magma at depths of several kilometers beneath the surface of the Earth. The youngest exposed pluton reported to date was the Takidani Granodiorite (~ 1.4 Ma) in the Hida Mountain Range of central Japan [1]. Using LA-ICP-MS and SHRIMP U-Pb zircon dating methods, this study demonstrates that the Kurobegawa Granite, situated in the middle of Cretaceous granitic batholith in the Hida Range, is as young as ~ 0.8 Ma [2]. Our data indicate multiple intrusion episodes in this pluton since 10 Ma with a ~ 2-million-year period of quiescence; hence, a future intrusion event is likely within 1 million years.

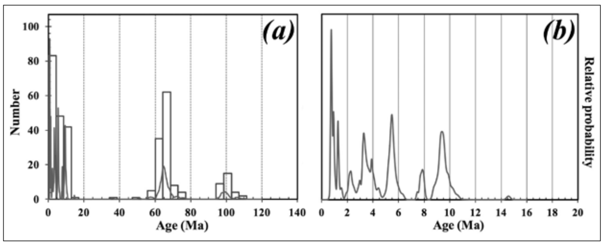


**Figure 1:** Age distribution of individual zircons. (*a*), Age distributions (cumulative probability distributions by *Isoplot 3.75*) for 320 grains of granitic origin with ages younger than 140 Ma. The peaks > 20 Ma are at 65 and 100 Ma. (*b*), Age distributions for 174 grains with ages < 20 Ma. The prominent peaks are 0.8, 1.3, 3.3, 5.5, 7.9, and 9.5 Ma.

[1] Sano, Y., *et al*. Ion microprobe U-Pb dating of Quaternary zircon: implication for magma cooling and residence time. J. Volcanol. Geotherm. Res. 117, 285–296 (2002).
[2] Ito, H. *et al*. Earth's youngest exposed granite and its tectonic implications: the 10–0.8 Ma Kurobegawa Granite. Natture Sci. Rep. 3, 1306; DOI:10.1038/srep01306 (2013).

# Impact history of lunar highlands recorded in MIL 090034, 090036, and 090070 lunar meteorites

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Clues from feldspathic lunar meteorites help in understanding lunar crustal evolution. We performed petrological, geochemical, isotopic studies of feldspathic lunar meteorites, MIL 090034 (MIL34), 090036 (MIL36), and 090070 (MIL70) [1,2]. Here, we report petrology and impact history of the three lunar crustal rocks.

MIL34 and MIL70 are crystalline melt breccias. MIL34 contains anorthositic clasts. We found a clast of noritic anorthosite with minor phosphate and zircon that seems to be of Mg-suite rock in MIL34. MIL70 is poorer in clastic components and has coarser-grained melt matrix. Plagioclase compositions of MIL34 and MIL70 peak sharply around $An_{96-97}$ as do those of FAN. Mg numbers of olivine vary from 58-65 with a few higher values. MIL36 is a fragmental or regolith breccia that contains fragments of K, Na-rich feldspar, phosphate, and zircon which are related to KREEP components. Plagioclase compositions vary from $\sim An_{84-98}$ with a broad peak at $An_{95-97}$.

Bulk chemical compositions are generally consistent with these petrologic data. The REE abundances of MIL34 and MIL70 (Sm~6×CI) are similar, whereas those of MIL36 are much higher (~30×CI) [1]. Also, MIL34 and MIL70 have similar cosmic ray exposure (CRE) ages indicating they are launch paired. MIL36 has a larger CRE age (~>70Ma) [2].

We suggest that MIL34 and 70 were derived from a large crater: MIL70 was deeply buried in the impact melt sheet, whereas MIL34 was closer to the surface on the basis of CRE and petrologic data. MIL36 was derived from a site near the KREEP-rich terrane. Ar-Ar ages for subsamples of MIL 34 and MIL70 range from 3.50±0.11 to 3.64±0.22 Ga, resp., and are 3.79±0.04 Ga for MIL36.

[1] Shirai *et al*. (2012) *LPSC* **43,** #2003. [2] Park *et al*. (2013) *LPSC* **43,** #2576.


DOI:10.1180/minmag.2013.077.5.25