**Rb-Sr ISOTOPIC SYSTEMATICS OF THE LHERZOLITIC SHERGOTTITE LEW88516.** L. E. Borg[1], L. E. Nyquist[1], and H. Wiesmann[2] [1]SN4/NASA Johnson Space Center, Houston TX 77058, [2]Code C23, Lockheed Martin, 2400 NASA Road 1, Houston TX 77258.

*Synopsis:* We have completed Rb-Sr isotopic analyses on mineral fractions and leachates from the Martian meteorite LEW88516 (LEW). This meteorite is classified as a lherzolitic shergottite and is mineralogically and geochemically very similar to the other two lherzolitic shergottites ALH77005 (ALH) and Y793605 (Y79) [1,2,3,4]. Our analyses yield a crystallization age of 183 ± 10 Ma and an initial $^{87}Sr/^{86}Sr$ ratio of 0.710518 ± 60. This age agrees well with the ~170 Ma age previously determined for LEW by the U-Th-Pb method by [5] and with the Rb-Sr age of 187 ± 12 Ma determined on ALH by [6], but is older than the 154 ± 6 Ma Rb-Sr age determined on ALH by [7]. The initial $^{87}Sr/^{86}Sr$ ratio of LEW is slightly higher than the initial $^{87}Sr/^{86}Sr$ ratios determined on ALH by [6, 7], suggesting that LEW and ALH may be derived from slightly different magma batches. The leachates of mineral fractions fall off the isochron because they have lower Rb/Sr and $^{87}Sr/^{86}Sr$ than their parental mineral fractions. The Rb-Sr isotopic systematics of the leachates are consistent with Rb removal and Rb/Sr fractionation from the host mineral fractions at ~90 Ma. This fractionation may be associated with secondary alteration or shock metamorphism.

*Introduction and Background:* The three lherzolitic shergottites that have been identified so far (LEW, ALH, and Y79) have very similar textures, mineralogies, and chemical compositions [1,2,3,4]. These meteorites exhibit both poikilitic and non-poikilitic textures. In the poikilitic areas pyroxene oikocrysts surround olivine and chromite, whereas in the non-poikilitic areas maskelynite is interstitial to a cumulus framework of olivine with minor pyroxene [1,2,3]. These textures suggest that, in contrast to the basaltic shergottites, the lherzolitic shergottites crystallized at depth [8].

Several petrographic features of the lherzolitic shergottites underscore potential problems with the isotopic analyses of these rocks and emphasize the need for very careful mineral separations. Shock features are ubiquitous throughout the lherzolitic shergottites and include the presence of maskelynite, mosaicism of olivine and pyroxene, and the presence of shock melts [2,7]. Shock melts are likely to have been re-equilibrated with the bulk rock at the time of the shock event [7] and therefore may have incorporated secondary alteration products that are not in isotopic equilibrium with LEW mineral separates. Thus, shock melts should be excluded from the mineral separates. An additional potential problem arises from the fact that the olivine compositions are too Fe-rich to be in equilibrium with the pyroxenes. The disequilibrium between olivine and pyroxene in the lherzolitic shergottites has been attributed to crystallization from different source liquids [7] and to near-solidus re-equilibration of the olivine in a closed system [1,9]. Obviously, xenocrystic olivine is not expected to lie on the isochron defined by the other phases and would have to be excluded from the age calculation.

*Analytical Procedures:* We have crushed and sieved ~220 mg of LEW at 74-150 µm, 44-74 µm, and <44 µm. Bulk splits were removed from the 150-74 µm and <44 µm size fractions and run as Wr-1 and Wr-2, respectively. Minerals were separated from the remaining powder using heavy liquids as follows: maskelynite (< 2.85 g/cm$^3$), Mg-pyroxene (2.85 - 3.28 g/cm$^3$), Fe-pyroxene (3.28 - 3.55 g/cm$^3$), and olivine (3.55 - 4.05 g/cm$^3$). Impact melt glass, composite grains, and extraneous minerals were removed from the mineral fractions by hand-picking. We estimate that all mineral fractions were at least 99% pure. The mineral fractions were leached in warm 1N HCl for 10 minutes prior to digestion. Detailed chemical separation and mass spectrometry procedures, as well as blanks, are similar to those reported in [10].

*Rb-Sr isochron:* Rb-Sr isotopic analysis of maskelynite, whole rock, olivine, and pyroxene fractions from LEW yield a crystallization age of 183 ± 10 Ma. Despite the fact that there is some scatter in the data, all of the analyzed mineral fractions lie on the isochron. This is somewhat surprising,

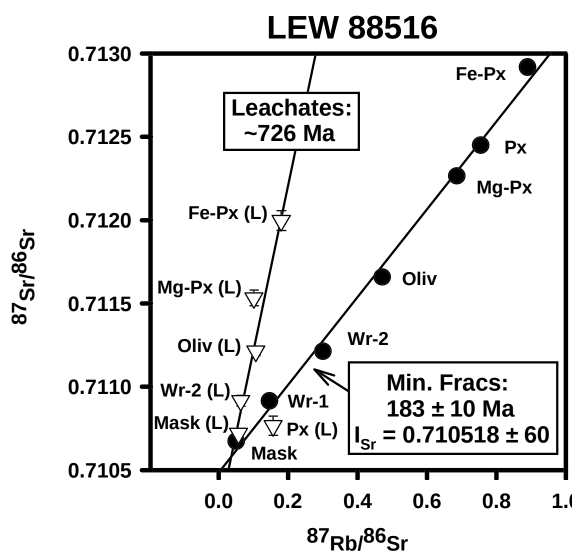


**Figure 1. Rb-Sr isochron plot of mineral, whole rock, and leachate fractions from LEW88516. A crystallization age of 183 ± 10 Ma and an initial $^{87}Sr/^{86}Sr$ of 0.710518 ± 60 is defined by all of the analyzed mineral fractions (solid circles) using $\lambda(^{87}Rb) = 0.01402\ (Ga)^{-1}$. Open triangles are analyses of leachates. Note that the leachates fall to the left of the mineral isochron and with the exception of Px (L) define a line with a slope corresponding to an age of about 726 ± 287 Ma.**

given the ubiquitous nature of shock melts in this meteorite, and indicates that the Rb-Sr isotopic systematics of the mineral fractions have not been significantly reset by shock metamorphism. The fact that olivine lies on the isochron indicates that this phase is probably not xenocrystic in origin and supports the suggestion by [1] and [9] that the disequilibrium between olivine and pyroxene is the result of subsolidus re-equilibrium in a closed system.

The Rb-Sr age determined on LEW is within uncertainty of ages determined on this meteorite by other techniques, as well as with ages determined on the other lherzolitic shergottites. Our age agrees well with the U-Pb analysis of LEW leachates and residues completed by [5] which intersect concordia at the lower intercept at ~170 Ma, as well as with the Rb-Sr age of 187 ± 12 determined on ALH by [6]. Although the U-Pb isotopic systematics of Y79 are complex, [11] have argued that their best data intersect concordia at 212 ± 62 Ma, and are therefore also in good agreement with the LEW Rb-Sr isochron. However, our Rb-Sr age for LEW is about 30 Ma older than the Rb-Sr age determined on ALH by [7].

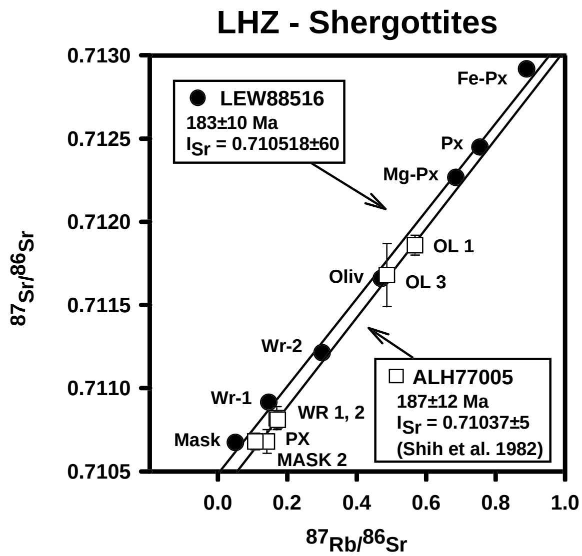


**Figure 2. Rb-Sr isochron plot of mineral fractions from LEW (solid circles) and ALH (open squares; data from 6). The ages for LEW (183 ± 10 Ma) and ALH (187 ± 12 Ma) are within analytical uncertainty. This is consistent with derivation of both meteorites from the same body of rock on Mars. The initial $^{87}Sr/^{86}Sr$ ratios differ by more than analytical uncertainty, however, and suggest that LEW and ALH were derived from slightly different magma batches.**

*Initial $^{87}Sr/^{86}Sr$:* The initial $^{87}Sr/^{86}Sr$ of LEW is about 150 ppm higher than the initial $^{87}Sr/^{86}Sr$ of ALH determined by [6] and about 100 ppm higher than the initial $^{87}Sr/^{86}Sr$ of ALH determined by [7]. These differences are outside the combined analytical uncertainties calculated from the individual isochrons. It is therefore likely, that despite their textural, mineralogical, geochemical, and chronological similarities, LEW and ALH are derived from different magma sources as suggested by [12] on the basis of slightly different bulk trace element abundances. Differences in initial Sr isotopic ratios of this magnitude are commonly observed in comagmatic terrestrial rocks. Therefore, perhaps the best explanation is that LEW and ALH represent very similar batches of magma that were contemporaneously intruded into the same pluton. LEW may be derived from a slightly different mantle source, or may have had slightly more interaction with the Martian crust than ALH, and thus assimilated slightly more radiogenic Sr.

*Leachates:* The leachates fall to the left of the mineral isochron (Figs. 1, 3), indicating that they contain a component that has a low Rb/Sr ratio. Leachates with similar characteristics have been observed in the basaltic shergottite QUE94201 (QUE) by [10]. However, unlike QUE, the LEW mineral separate/leachate pairs appear to define ages of ~90 Ma (Fig. 3). The chronological relationship between mineral separate/leachate pairs may simply be fortuitous, and reflect ternary mixing between various primary igneous components in the meteorite and secondary alteration products with low Rb/Sr and high $^{87}Sr/^{86}Sr$ ratios. On the other hand, the fact that the same age is reproduced by four different mineral separate/leachate pairs is not required by ternary mixing, and suggests that Rb and Sr in the host silicates may have been fractionated and partitioned into leachable sites at ~90 Ma. This process may have resulted in Rb loss, but could not have added significant amounts of extraneous Sr. The fractionation of Rb from Sr may be the result of secondary alteration processes or shock metamorphism.

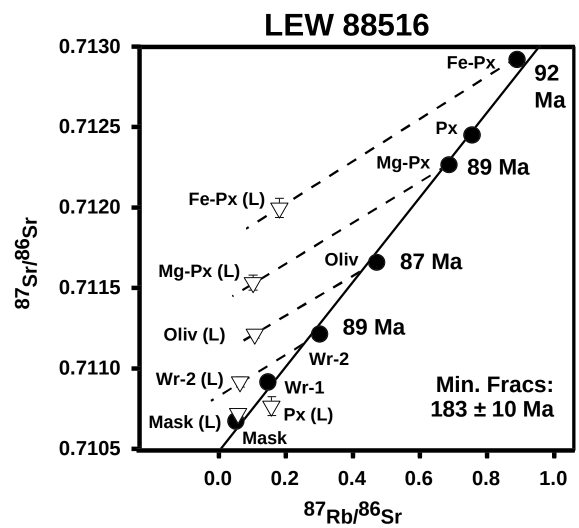


**Figure 3. Rb-Sr isochron plot of mineral fractions and leachates from LEW. Symbols are the same as in Fig. 1. Note that the leachates fall to the left and above the mineral isochron and that tie lines (dashed) between mineral separate/leachate pairs have slopes corresponding to ages between 87 and 92 Ma.**

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