LEAD AND STRONTIUM ISOTOPE STUDIES OF BASALTIC LAVAS FROM NORTH AMERICA: IMPLICATIONS FOR COUPLED MANTLE AND CRUST EVOLUTION. William P. Leeman, Dept. of Geology, Rice University, Houston, Texas 77251.

Lead and strontium isotopic analyses have been completed for representative suites of late Cenozoic basaltic lavas and related differentiates from several areas in the western United States, and for 1.1 b.y. old lavas of the Keeweenawan province in Minnesota. These volcanic suites occur in areas underlain by crust of varied age. A brief description of each occurrence follows.

Keeweenawan. Vast outpourings of predominantly basaltic flood lavas are related to crustal rifting in Proterozoic (Grenvillian) time. In Minnesota, these lavas occur in a terrane of crystalline basement rocks, some of which yield isotopic ages of 3.5 to perhaps 3.8 b.y. (Goldich and Wooden, 1980; McCulloch and Wasserburg, 1980; Futa, 1981; Peterman et al., 1980), although younger thermal events are more commonly recorded in this area.

Snake River Plain - Yellowstone. Voluminous bimodal basalt-rhyolite extrusives from a arcuate trace across southern Idaho and northwestern Wyoming; these rocks decrease in age (15 m.y. to Holocene) systematically from west to east. They presumably define the trace of a stationary hot-spot or melting anomaly beneath the southwesterly migrating North American Plate (Leeman, 1982). Crustal xenoliths in some of the lavas and exposed crystalline basement rocks in the Yellowstone area yield isotopic ages of about 2.8 - 3.0 b.y. (Leeman, 1979).

Mt. Taylor (Colorado Plateau). Scattered Pliocene-Holocene lavas of alkali-olivine basalt (some with ultramafic xenoliths), tholeiitic basalt, and a central volcano of calc-alkaline lavas occur on the Colorado Plateau in west-central New Mexico (Leeman and Lipman, in prep.). Crystalline basement rocks exposed in nearby ranges are of Proterozoic age (1.5 - 1.7 m.y.; Hedge, 1972).

Sierran province. Scattered Pliocene-Holocene lavas of alkali-olivine basalt and trachybasalt occur in the Sierra Nevada range and a broad belt to the east (SE. California and S. Nevada). Many of these lavas contain ultramafic xenoliths; they are characterized by high Sr contents (most >1000 ppm). Precambrian basement rocks in the area are poorly dated (>1.6 b.y.; Kistler and Peterman, 1973), but zircon xenocrysts (of uncertain provenance) from Jurassic dikes in the area yield U-Pb ages of ca 2.8 b.y. (Chen and Moore, 1979). These sparse data suggest the presence of ancient crust beneath the area.

The analyzed lavas are considered to sample mantle source areas and to have experienced little if any isotopic exchange with crustal rocks like those exposed at the surface. This view is supported by geologic, petrographic and geochemical data, although some contaminated lavas have been identified from the Snake River Plain and Mt. Taylor areas. Lead isotopic data for each of these suites define linear arrays in 206/204 vs 207/204 plots, which yield Pb-Pb ages comparable with or slightly lower than those of the oldest crustal rocks from each area. No correlation is found between Pb and Sr isotopic compositions or other geochemical parameters, with exception of tholeiitic and calc-alkaline rocks from Mt. Taylor and hybrid lavas from the Snake River Plain. Accordingly, the Pb-Pb ages are considered
Leeman, W. P.

representative of the mantle source areas. Initial Sr isotopic ratios are somewhat varied for each suite, and relatively high compared to those for ocean floor basalts, but fall within observed ranges for oceanic island basalts.

It is proposed that the mantle source areas are isotopically heterogeneous, much as has been suggested for sub-oceanic mantle. The elevated Sr isotopic ratios and large isotopic variations for both Sr and Pb most simply are related to small ranges in parent-daughter isotopic ratios (Rb/Sr, U/Pb) that have persisted in each source area for times on the order of the age of the overlying continental lithosphere. According to this interpretation, substantial volumes of sub-continental lithospheric mantle must have been isotopically "homogenized" at the times of major crustal development or rejuvenation in the respective areas, and must have remained effectively isolated from convecting asthenospheric mantle since those major events. Lead isotopic studies of mafic volcanic rocks may therefore prove useful in delimiting the extent of ancient crustal (and mantle) terranes in areas where crystalline basement rocks are not exposed or where such rocks are overprinted by subsequent thermal events.

<table>
<thead>
<tr>
<th>Volcanic Suite</th>
<th>207/204-206/204 slope ± s.d.</th>
<th>Pb-Pb source age (b.y.) at time of volcanism</th>
<th>Pb-Pb source &quot;age&quot; (b.y.) today</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keeweenawan</td>
<td>0.164 ± 0.019(^a)</td>
<td>2.50 ± 0.19</td>
<td>~ 3.6</td>
</tr>
<tr>
<td>Snake River</td>
<td>0.160 ± 0.007</td>
<td>2.46 ± 0.08</td>
<td>~ 2.5</td>
</tr>
<tr>
<td>Mt. Taylor</td>
<td>0.091 ± 0.012</td>
<td>1.45 ± 0.26</td>
<td>~ 1.5</td>
</tr>
<tr>
<td>Sierran</td>
<td>0.189 ± 0.014</td>
<td>2.73 ± 0.12</td>
<td>~ 2.7</td>
</tr>
</tbody>
</table>

\(^a\) based on regression of initial Pb isotope ratios calculated at 1.14 b.y. ago

References: