Distribution of Rubidium between Sodic Sanidine
and Natural Silicic Liquid*

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Abstract. Phenocrysts of sodic sanidine from twelve upper Cenozoic units of silicic ash-flow
tuff and lava from the Western United States contain from 0.25 to 0.45 the Rb present in
the associated groundmass materials. The ratios of potassium to rubidium in the sanidines
are, on the average, about four times greater than those of the groundmass. Separation
of phenocrystic sanidine from salic melts provides an efficient method for raising the Rb
content and lowering the K/Rb ratio of the melts, although the amount of differentiation
probably is limited by continuous reequilibration of the alkalis between crystal and liquid
phases through ion exchange. Syenites of cumulate origin will have appreciably lower Rb con-
tents and higher K/Rb ratios than the melts from which they precipitated. Available data
on the distribution of Rb between synthetic biotite and K-sanidine demonstrate that the sepa-
ration of biotite probably will not deplete salic melts in Rb relative to K.

Introduction
Rubidium is a useful geochemical tracer for the study of igneous rocks of all
compositions. In addition to the great importance of Rb$^{87}$ as a radiogenic parent,
the Rb$^+$ ion, because of its large size and single charge, is highly concentrated—
both absolutely and with respect to K—in early partial melt fractions of mafic
and ultramafic materials (Gast, 1968). For the same reasons, in favorable situations
the concentration of Rb can provide a nearly quantitative measure of the degree
of fractional crystallization for members of a cogenetic suite of relatively K-poor
rocks. The usefulness of Rb for studying K-rich igneous suites has been limited
by the scarcity of data pertaining to the distribution of the element between
magmatic liquids and the common K-bearing silicate phases.

We have determined the Rb and K contents of phenocrystic sanidine and
associated groundmass material from twelve upper Cenozoic ash-flow tuffs and
lavas from the Western United States (Table). The purpose of this paper is to
present these data and to briefly discuss certain petrologically significant aspects
of the partition of Rb between sanidine and magmatic liquid.

Rocks Studied
All the rocks studied appear very fresh and show no megascopie or microscopie
signs of alteration except the secondary hydration of the glass phase in certain
of the glassy specimens. As shown by the low Sr contents of the sanidines—

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### Table. Potassium oxide and rubidium contents and calculated partition coefficients for sanidine and groundmass material from silicic volcanic rocks from the Western United States

<table>
<thead>
<tr>
<th>Sample</th>
<th>K₂O (wt. percent)</th>
<th>Rb (ppm)</th>
<th>Rbₛ/Rbᵍᵃ</th>
<th>Kᵍ⁻Rbₛ/ Rbᵍ⁻Kₛᵃ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sanidine</td>
<td>Groundmass</td>
<td>Sanidine</td>
<td>Groundmass</td>
</tr>
<tr>
<td>1.</td>
<td>10.76</td>
<td>4.9</td>
<td>107</td>
<td>282</td>
</tr>
<tr>
<td>2.</td>
<td>6.36</td>
<td>4.8</td>
<td>60</td>
<td>220</td>
</tr>
<tr>
<td>3.</td>
<td>7.00</td>
<td>5.2</td>
<td>53</td>
<td>173</td>
</tr>
<tr>
<td>4.</td>
<td>6.59</td>
<td>4.86</td>
<td>72ᵇ</td>
<td>228</td>
</tr>
<tr>
<td>5.</td>
<td>6.69</td>
<td>4.6</td>
<td>120</td>
<td>315</td>
</tr>
<tr>
<td>6.</td>
<td>7.1</td>
<td>4.6</td>
<td>100</td>
<td>300</td>
</tr>
<tr>
<td>7.</td>
<td>6.68</td>
<td>5.17</td>
<td>48</td>
<td>123</td>
</tr>
<tr>
<td>8.</td>
<td>6.62</td>
<td>4.7</td>
<td>40</td>
<td>156</td>
</tr>
<tr>
<td>9.</td>
<td>8.93</td>
<td>4.6</td>
<td>67</td>
<td>185</td>
</tr>
<tr>
<td>10.</td>
<td>7.67</td>
<td>4.65</td>
<td>117</td>
<td>260</td>
</tr>
<tr>
<td>11a.</td>
<td>7.59</td>
<td>4.6</td>
<td>106</td>
<td>277</td>
</tr>
<tr>
<td>11b.</td>
<td>7.45</td>
<td>4.60</td>
<td>135</td>
<td>351</td>
</tr>
<tr>
<td>11c.</td>
<td>7.33</td>
<td>4.6</td>
<td>90</td>
<td>357</td>
</tr>
<tr>
<td>12.</td>
<td>5.64</td>
<td>6.0</td>
<td>45</td>
<td>180</td>
</tr>
</tbody>
</table>

ᵃ s = sanidine; g = groundmass.
ᵇ An Rb content of 90 ppm ± 15% was determined by optical emission spectrographic methods of Annett (1964) by Joseph Haffty.

1. Bishop Tuff, Pleistocene (Gilbert, 1938). Field No. UB
2. Labyrinth Canyon Member of the Thirsty Canyon Tuff, Pliocene (Noble et al., 1964; Noble and Christiansen, 1968). Field No. Ttl-WBM.
3. Trail Ridge Member of the Thirsty Canyon Tuff, Pliocene (Noble et al., 1964). Field No. CS-42.
4. Spearhead Member of the Thirsty Canyon Tuff, Pliocene (Noble et al., 1964; Noble, Bath et al., 1968). Field No. Ttsu-OB.
5. Unnamed local ash-flow unit partly filling the Kane Springs Wash caldera (Noble, 1968). Field No. KW-29.
6. Uppermost ash-flow sheet (Tv-k-T of Cook, 1965) of the Kane Wash Tuff, Miocene, at the type section of the formation (Cook, 1965; Noble, 1968). Field Nos. TK-T, TK-TV.
8. Grouse Canyon Member of the Belted Range Tuff, Miocene (Sargent et al., 1965; Noble, Sargent et al., 1968). Field No. WPN-100 F.
9. Tub Spring Member of the Belted Range Tuff, Miocene (Sargent et al., 1965). Field No. WPN-500.

from 2 to 35 ppm for all except 1 and 3, which contain 150ᵇ and 59 ppm Sr, respectively—and shown by other chemical and mineralogical data, the rocks are highly to very highly differentiated. Specimens 1, 3, and 12 are subalkaline; the remainder are slightly to moderately peralkaline. The groundmass materials of specimens 7 and 12, which contain 14 and 15 weight percent Al₂O₃, respectively, are significantly undersaturated with respect to quartz. Specimens 3 and 8,