Title of article: Oxygen and hydrogen isotope studies of a Precambrian granite-rhyolite terrane, St. Francois Mountains, southeastern Missouri

Author(s): Wenner et al.

see GSA Bulletin v. 87, p. 1587 - 1598

Contents 18 p.

Appendix

Sample locations  p. 2 - 5

Pet. and Is. data  6 - 18
APPENDIX

for

OXYGEN AND HYDROGEN ISOTOPE STUDIES OF A PRECAMBRIAN
GRANITE-RHYOLITE TERRANE, ST. FRANCOIS MTNS., S.E. MISSOURI

By

David B. Wenner

and

Hugh P. Taylor, Jr.

(to be placed in the document-retrieval depository)
SAMPLE LOCATIONS

All sample locations utilize the same notation outlined by Tolman and Robertson (1969, p. 3). In the diagram below, the location of the dot would normally be described as NE1/4 SW1/4 NW1/4 sec. 6, T.36N., R.3E. The method used in this report reverses the order and indicates fractional quarter subdivisions of the section by letters. By this method, the location is given as T36N,R3E:6bca.
<table>
<thead>
<tr>
<th>Sample</th>
<th>Quadrangle</th>
<th>Location</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-1</td>
<td>Fredericktown 15'</td>
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<td>Miller and Sybes quarry site</td>
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<td>Notes</td>
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<td>F-4</td>
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<td>adjacent to river at park</td>
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<td>F-8</td>
<td>Iron Mtn. Lake 7½'</td>
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<td>F-13</td>
<td>Iron Mtn. Lake 7½'</td>
<td>T35N,R4E:26ab-center</td>
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Petrographic Descriptions and Isotope Data for St. Francois Samples

Notation Employed

\[ Q = \delta^{18}O \text{ of quartz} \quad F = \delta^{18}O \text{ of feldspar} \quad WR = \delta^{18}O \text{ of whole rock} \]

\[ Q_p, F_p = \delta^{18}O \text{ of phenocrysts} \quad Q_m, F_m = \delta^{18}O \text{ of matrix groundmass} \quad D = \delta^D \]

Calc = calculated  \( (HS) \) = hand specimen description only

All samples designated by \( B \) series (\( B-1 \), \( B-4 \), etc.) are those collected by Forbes Robertson and sold commercially by Western Minerals Inc. Samples designated by \( M \) or \( F \) were collected by the senior author (D.B.W.).

The following rock unit abbreviations are the same as those shown on The Geologic Map of The Precambrian of Missouri (see Tolman and Robertson, 1969). All sample locations are shown on figures 2, 3 and 4 except for \( B-27 \) and \( M-20a \).

- \( Bbm \) - Brown Mtn. Rhyolite Porphyry
- \( Bg \) - Graniteville Granite
- \( Bh \) - Butler Hill Granite
- \( Bs \) - Silvermine Granite
- \( Mb \) - Buford Granite Porphyry
- \( MB \) - Middlebrook Group Volcanics
- \( MBm \) - Marlow Mtn. Rhyolite
- \( MBo \) - Oak Mtn. Rhyolite

- \( MBp \) - Pilot Knob Felsite
- \( MBr \) - Royal Gorge Rhyolite
- \( Mm \) - Munger Granite Porphyry
- \( Ms \) - Slabtown Granite
- \( Mst \) - Stono Granite
- \( Vf \) - French Mills Rhyolite
- \( Vh \) - Hogan Mtn. Rhyolite
- \( Vs \) - Stouts Ck. Rhyolite
B-1 (Bh) equigranular, grayish-white granite; grains 2-4 mm; perthite (30%), slightly turbid; plagioclase (30%), slightly sericitized; quartz (30%), shows some granophyric intergrowths with perthite; mafics (10%) include biotite, minor chlorite; chlorite replacing biotite; trace epidote

\[ Q = 9.3, \ F = 9.1 \quad WR \ (Calc) = 9.1 \]

B-4 fine-grained (~1 mm) red granophyre phase of (Bh); perthite (50%), brick-red; plagioclase (20%), slightly sericitized; quartz (30%) granophyrically intergrown with perthite; mafics (5%) include muscovite, chlorite; trace fluorite, calcite

\[ WR = 10.0 \]

B-5 (Bh) equigranular coarse-grained (~3 mm) reddish-brown granite; plagioclase (30%), slightly sericitized; perthite (40%), red-brown, turbid; quartz (25%); mafics (5%) include chlorite, epidote; trace calcite

\[ Q = 9.3, \ F = 8.8 \quad WR \ (Calc) = 8.9 \]

B-7 diabase porphyry dike in (Ms); metadiabase containing megaphenocrysts (20%, 10 mm) have translucent saussuritized rim with epidote-albite core; phenocrysts (20%, 3 mm) of saussuritized plagioclase and actinolite; ophitic groundmass (60%, average 0.1 mm) consists of plagioclase, actinolite, quartz, epidote, chlorite.

megaphenocrysts - rim = 8.1, core = 8.3; groundmass = 8.4

B-8 (Vs) purplish-gray rhyolite porphyry; phenocrysts (2-3 mm) of quartz (15%), highly altered perthite (25%), and green poikilitic hornblende (10%); groundmass consists of quartz and feldspar in roughly equal proportions

\[ WR = 9.0 \]
B-9 coarse-grained red granite (unit undefined); equigranular, 1-2 cm; patchy white perthite (50%); quartz (40%); mafics (5%), partly chloritized green hornblende; fluorite (5%) in small fractures with epidote, calcite; miarolitic cavities (~5 mm) lined with fluorite, chlorite, opaques

\[ Q = 9.2, \ F = 8.3, \ WR = 8.6 \]

B-10 basalt dike in granite sample B-9; metabasalt with ophitic textures preserved (~3 mm); contains albite, actinolite, minor quartz, opaques

\[ WR = 6.5 \]

B-12 (Vs) dark purple porphyritic rhyolite; phenocrysts of turbid red K-feldspar (15%, 2 mm) and quartz (15%, ~1 mm); groundmass (70%), is very fine-grained quartz-feldspar mixture; fractures contain small (~1 mm) patches of epidote and opaques

\[ Q_p = 9.2, \ Q_m = 9.7, \ WR \ (of \ matrix) = 11.3, \ F_p = 10.4, \ F_m(\text{calc}) = 12.9 \]

B-13 (Bbm) brownish-purple porphyritic rhyolite; phenocrysts (15-20%) of quartz (~2 mm); groundmass of feldspar and quartz in spherulitic texture, with aggregate size 0.2 mm; 2-3% muscovite in groundmass

\[ WR = 12.1 \]

B-14 coarse-grained diorite in Bbm; diabase containing partially saussuritized plagioclase (50%, up to 5 mm long-grains), clinopyroxene and a smaller amount hypersthene (30%); opaques (10%); olivine (5-10%)

\[ F = 8.9, \ WR = 7.5 \]

B-16 metabasalt in (MB); fine-grained basalt with sparse phenocrysts; microvesicles (5%) filled with chlorite; phenocrysts (5%) of plagioclase; groundmass of actinolite, albite, and opaque; subophitic texture persisted; probably volcanic flow

\[ WR = 10.1 \]
B-17 (Vf) purplish-brown porphyritic rhyolite; phenocrysts (.8 mm) of quartz (5%), brown turbid microcline and altered plagioclase (50%), and altered mafic phenocrysts (10%) of sericite and opaques pseudomorphic after hornblende (?); groundmass (35%) is largely a fine-grained mixture of quartz and feldspar

WR = 11.7

B-18 (MBm) reddish-brown porphyritic rhyolite; phenocrysts (up to .8 mm) of brown turbid microcline microperthite (10%) and quartz (10%); groundmass of quartz, feldspar, with minor chlorite, opaques, and green amphibole

WR = 10.7, Q = 10.5

B-19 albitite (?) facies of diabase dike in (Vs); white, coarse-grained rock contains plagioclase (60%) and microcline (20%), up to 3-4 mm, and quartz (20%) up to 1 mm; trace amounts of calcite, clinopyroxene

Q = 10.7, F = 9.4, WR(calc) = 9.8

B-20 diabase porphyry in (Ms); plagioclase phenocrysts (20-30%, 10 mm) are subhedral, highly saussuritized; ophitic matrix (1 mm) of partially sericitized plagioclase (40%), clinopyroxene (25%) slightly altered to chlorite, and chlorite (20%) pseudomorphic after clinopyroxene (?); small amount of magnetite, pyrite

F phenocrysts = 9.9, matrix = 6.3, D = -45 (of saussurite)
D = -44(of chlorite in matrix)

B-21 (MBr) brick-red porphyritic rhyolite; phenocrysts of quartz (15%) and sericitized and saussuritized feldspar (5%); groundmass medium to fine-grained spherulites of turbid feldspar, quartz, minor muscovite, and opaques

WR = 12.9
B-23 (Bg) coarse-grained, 1-2 mm, pink equigranular leucogranite; perthite (35%) is turbid brown; plagioclase (25%); quartz (40%); trace of chlorite, muscovite, opaques

\[ WR = 9.6, Q = 9.6, F = 9.5 \]

B-24 porphyritic granite dike in sample B-23; phenocrysts (up to 4 mm) of quartz (15%) and partially sericitized microcline (5%); red-brown groundmass, .3-.5 mm, of microcline perthite (25%), plagioclase (20%), quartz (30%), and mafics (5%) consisting of biotite, chlorite, muscovite

\[ Q = 9.8, F = 9.1 \quad WR = 9.4 \text{ (calc)} \]

B-25 (Mst) purplish-brown porphyritic granite containing brown phenocrysts of feldspar; minor amounts of black xenoliths (?) of very fine-grained lenticular masses (HS)

\[ WR = 5.4, Q = 4.8, \text{ Magnetite} = -3.9, F (\text{calc}) = 5.8 \]

B-26 (phase of Bb) fine-grained reddish-brown porphyritic leucogranite; phenocrysts of turbid brown perthite (40%, up to 1 mm); groundmass (.2 mm) of microcline (10%) and quartz (35%) micrographically intergrown with alkali feldspar, plagioclase (10%), chlorite (5%), minor muscovite, chlorite

\[ Q = 9.6, F = 8.6, WR (\text{calc}) = 8.9 \]

B-27 Mudlick Latite (this sample is located at SE ¼, SE ¼ sec. 14, T29N, R3E, Piedmont quadrangle and hence is not shown on maps in figures 2, 3) porphyritic rhyolite; phenocrysts (40%) of plagioclase, microcline (turbid), quartz; groundmass (60%) of very fine-grained quartz and feldspar; 1 mm thick vein of epidote cross cuts sample

\[ WR = 7.3 \]
B-28 (Bs) porphyritic granite with turbid-brown, partially sericitized feldspar phenocrysts, 1-2 mm (40%); matrix (.5 mm) of quartz (30%), plagioclase (20%) and mafics (10%) of hornblende partially altered to chlorite, sphene

\[ Q = 10.2, \, F = 9.4, \, WR \ (calc) = 9.7, \, DWR = -52 \]

M-2 (Vs) porphyritic light brown to gray rhyolite; phenocrysts (up to 2 mm) of quartz (10%), perthite (15%), and green poikilitic hornblende (5%); groundmass is very fine grained mixture of quartz, feldspar, green amphibole, and minor opaques

\[ Q_p = 9.1, \, F_p = 7.2, \, Q_m = 9.4, \, F_m \ (calc) = 6.4, \, WR \ matrix = 7.9 \]

M-4d (Bh) white to light pink porphyritic granite with large 2-3 cm euhedral perthite phenocrysts (20%) set in medium to coarse-grained (1-2 mm) groundmass; rim of perthite phenocrysts is highly turbid and exhibits granophyric intergrowth with quartz; groundmass is mixture of equal amounts of quartz and perthite in micrographic texture; mafics (5%) of biotite, chloritized green hornblende; traces of epidote, opaques, and fluorite

\[ Q = 9.2, \, F = 8.5, \, WR \ (calc) = 8.7 \]

M-6a grayish brown porphyritic rhyolite dike in (Vs); phenocrysts of:
alkali feldspar (20%, 2-3 mm) with intense white, turbid alteration to sericite and epidote in the core; plagioclase (20%, 1 mm), contains numerous very fine-grained inclusions of chlorite, epidote; quartz (30%, up to 1 mm) shows some suggestion of granophyric texture; mafics (10%) of chlorite and green hornblende; groundmass is very fine mixture of quartz and feldspar in semispherulitic pattern; epidote abundant in groundmass

\[ F = 7.1, \, WR = 7.4 \]
M-7 (Bh) light pink equigranular coarse-grained granite; perthite (50%, up to 2 mm) is brown, turbid and partially altered to sericite, epidote, hematite; plagioclase (10%); quartz (30%) shows suggestion of micrographic textures adjacent to perthite; biotite (10%) shows much alteration to chlorite

\[ F = 9.1, \ Q = 9.6, \ WR \ (\text{calc}) = 9.3, \ DWR = -47 \]

M-8 (Ms) fine-grained, purplish-gray equigranular (0.8 mm) granite; perthite (30%) white turbid with micrographic intergrowths of quartz near edges; plagioclase (30%) shows some alteration to epidote; quartz (20%); mafics (5%) of chlorite, probably a replacement of hornblende; traces of biotite, actinolite, opaques, and calcite

WR = 9.7

M-9a porphyritic metabasalt; phenocrysts (15%, up to 1 mm) of plagioclase; microvesicle (?) fillings by chlorite

WR = 7.8

M-12b (Mst) purplish-red porphyritic granite with sparse miarolitic cavities; brownish-red turbid phenocrysts of K feldspar (15%, 1-3 mm) in groundmass of equigranular (0.8 mm) quartz, alkali feldspar, and minor actinolite; trace of fluorite, sphene, opaques

\[ F = 6.6, \ Q = 5.4, \ WR = 6.2 \]

M-14 (MBp) grayish-brown very fine-grained rhyolite, showing slight suggestion of flow structure (HS)

WR = 12.1
M-15 (MBo) dense, black, sparsely porphyritic rhyolite or andesite; phenocrysts of plagioclase (10%) in very fine-grained black matrix (HS)

\[WR = 8.2\]

M-17 (Mb) porphyritic granite with purplish-brown phenocrysts (20%, 1 mm) consisting of equal amounts of brown turbid microcline, plagioclase, and quartz; groundmass (80%, up to .4 mm) of K-feldspar, plagioclase, quartz and minor hornblende

\[WR = 9.0\]

M-18 (Vh) purplish gray rhyolitic ash-flow tuff composed of phenocrysts of brownish-red microcline microperthite (20%) and quartz (10%); groundmass (70%, .1 to .01 mm) consists of quartz, feldspar, and minor disseminated opaques

\[F_p = 8.8, \; WR = 9.4\]

M-19 (Mst) purplish-red porphyritic granite; phenocrysts (40%, 1 mm) of equal amounts of quartz and brown turbid K-feldspar; groundmass, .2-.4 mm, dominantly quartz and K-feldspar with minor opaques, chlorite

\[WR = 8.6, \; Q = 8.8, \; F = 8.3\]

M-20a (Bb) porphyritic, purplish-pink leucogranite; phenocrysts (2 mm) of quartz (20%) and perthite (25%) in finer-grained (.6 mm) groundmass (50%) of quartz and feldspar; minor mafics (5%) of epidote, chlorite; granophyric textures common

\[Q = 8.8\]

M-20a-1 (Bb) fine-grained part of sample M-20a; probably chill zone at contact with volcanics; medium to fine-grained red, equigranular (.6 mm) granite with quartz and granophyrically intergrown perthitic feldspar; feldspar is highly turbid brown; contains sparse miarolitic cavities

\[Q = 8.4, \; F = 8.2\]
M-20b (Mst) dark, purplish-brown and green, fine-grained porphyritic granite; phenocrysts (15%) consist of brown, turbid feldspar (1-2 mm) and quartz (1 mm) set in a fine-grained matrix (.3-.5 mm) of similar material; matrix also contains minor (15%) chlorite, magnetite, sphene, epidote

WR = 6.0, Q = 5.3, DWR = -65

M-20c (Vs) gray porphyritic rhyolitic ash-flow tuff; phenocrysts of turbid brownish-red K-feldspar (20%, up to 3 mm), quartz (10%, up to 1 mm), and green hornblende (5%); groundmass of dominantly quartz and feldspar with traces of chlorite; contains rock fragments (5%) of basalt up to 3-5 cm

Qp = 8.7, Fp = 7.1, WR matrix = 7.7

M-22 (Vs) dark purplish-brown porphyritic rhyolite or ash-flow tuff with phenocrysts of reddish-brown, turbid K-feldspar (10%, up to 2-3 mm) and quartz (10%, up to 2 mm); groundmass of quartz and feldspar with minor disseminated opaque dust; some suggestion of flow structure

Qp = 10.2, Fp = 10.1, WR (groundmass) = 10.6, Qm = 10.6, Fm (calc) = 10.6

M-26 (Bh) reddish-brown, equigranular, medium grained (1 mm) leucogranite; contains quartz, alkali feldspar in nearly equal proportions; mafics (~5%) show alteration to limonite (HS)

Q = 9.3, F = 9.4 WR (calc) = 9.3

M-27 dark greenish-gray metabasalt dike in (Bh); ophitic textures preserved, with grains up to 1 mm; albite (30%), actinolite (15%), chlorite (25%), carbonate (15%), quartz (5%), opaques (10%)

WR = 7.3, D = -60
M-29c  porphyritic metadiabase; phenocrysts (10%, up to 2 mm) of highly sericitized plagioclase; groundmass (10%, .5 mm) contains feldspar, actinolite, chlorite, opaques with minor quartz; ophitic textures well preserved

WR = 7.1

M-31 (Bbm) sparsely porphyritic purplish-red rhyolitic ash-flow tuff; phenocrysts (5%, 1 mm) of sericitized feldspar; groundmass of very fine-grained quartz, feldspar, and opaques

WR = 12.2

M-35 (MB) porphyritic rhyolitic ash-flow tuff; feldspar phenocrysts (10% ~.5 mm) of highly turbid, red-brown microcline; very fine-grained matrix of quartz, feldspar, and opaques; buff to pink, elongated rock fragments composed dominantly of fine-grained quartz, feldspar, and green hornblende (up to 3 cm) define flow structure and occupy 25% of rock

WR = 7.3

M-36 (MBp) light, purplish-pink porphyritic rhyolitic ash-flow tuff; phenocrysts (25%) consist of highly sericitized feldspar containing numerous fine-grained masses of muscovite up to .2-.3 mm; quartz (5%, .3-.4 mm) highly corroded; opaques (5%, up to .5 mm); groundmass is very fine grained (~.01 mm) mixture of quartz and sericitized feldspar; rock fragments consist of quartz, feldspar, sericite

WR = 11.0, DWR = -40
M-37 (Vs) dark purple porphyritic rhyolite; phenocrysts of highly corroded, reddish-brown microcline perthite (20%) and quartz (15%); groundmass is largely quartz and brownish-red feldspar; traces of small vesicles

\[ F_p = 11.1, Q_p = 9.6, \text{WR} = 12.1, Q_m = 11.7, F_m (\text{calc}) = 12.5 \]

M-40 (MBr) porphyritic black to dark purple rhyolite; phenocrysts of highly turbid microperthite (?) (10%, up to 5 mm), brown-turbid plagioclase (10%) and green hornblende (5%); groundmass is very-fine grained mixture of quartz and feldspar in spherulitic pattern; minor amounts of light brown biotite occur in patches

\[ \text{WR} = 11.4, F_p = 10.7 \]

M-41 (Vh) dark, purplish-brown, very fine-grained rhyolitic ash-flow tuff with sparse, white feldspar and quartz phenocrysts (10%, 2 mm); lenticular light, reddish-purple fragments (15% of sample, up to 2 centimeters long) contain quartz and feldspar phenocrysts up to 2 mm along with some altered green hornblende (?) (HS)

\[ \text{WR} = 12.1, Q_m = 10.9, F_m = 13.3 \]

F-1 (Vh) porphyritic ash-flow tuff; phenocrysts (~1 mm) of lightly turbid, reddish-brown microcline (10%) and plagioclase (10%); groundmass (~1 mm) is very fine-grained mixture of quartz and feldspar; elongated rock fragments (1-2 cm) make up about 10-20% of the sample

\[ \text{WR} = 13.8 \]

F-2 (Mm) light brown porphyritic granite; phenocrysts (5%) of feldspar in equigranular groundmass of feldspar, quartz, minor chlorite and biotite (HS)

\[ Q = 10.6, F = 12.4, \text{WR (calc)} = 11.8 \]
F-4 porphyritic basalt dike in (Vh); phenocrysts (15%, up to 1 cm) consist of olivine rimmed by pyroxene; fine-grained matrix consists of plagioclase and clinopyroxene; groundmass is slightly altered
WR = 9.5

F-8 (Mst) fine-grained, purplish-gray porphyritic granite containing greenish patches of epidote; phenocrysts (2-3 mm) of brown turbid alkali feldspar (20%) and quartz (10%) in groundmass of similar material; mafics (10%) consist of epidote, chlorite, calcite, opaques; granophyric textures common
Q = 4.6, F = 5.2, Q vein = 5.8

F-10 (Mst) purplish-brown porphyritic granite; perthite (50%, 2 - 4 mm) with granophyric intergrowth developed adjacent to phenocrysts; plagioclase (10%) and quartz (20%) show embayment; clinopyroxene (10%) is highly fractured; opaque (5%); traces of fluorite, actinolite, chlorite, epidote (.4 mm) pseudomorphomorphic after hornblende (?)
Q = 4.7

F-11 (Mst) fine-grained, purplish-gray granite containing quartz, alkali feldspar, and minor amounts of altered mafics, opaques; shows some fracturing and contains quartz veins (HS)
F = 5.3, Q = 5.2

F-12 (Bb) coarse-grained granite with brick red, turbid, granophyrically intergrown perthitic feldspar (50%), quartz (40%), plagioclase (10%), and minor muscovite
Q = 8.7, F = 8.6
F-13 (Mst) light pink to purple porphyritic leucogranite; phenocrysts (20%) consist of sericitized plagioclase, perthite and quartz; matrix of similar composition; minor epidote, chlorite; granophyric textures common

Q = 10.1, F = 11.6