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The oxygen isotope composition of selected quartzites of White Pine County, Nevada, and nearby areas

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Abstract

Oxygen isotope compositions are listed for 31 quartzites from eastern Nevada and nearby areas, and oxygen isotope fractionation data are presented for quartz-muscovite pairs recovered from 12 of these quartzites. The information presented may be useful in directing future studies of the igneous and metamorphic rocks of eastern Nevada.

Introduction

During the past 20 years a number of studies have focused on the chemical and isotopic composition of the late Precambrian and Early Cambrian metasediments (mostly quartzites) of eastern White Pine County, Nevada, and nearby areas. Interest in these rocks grew from the discovery that their constituent micas give Tertiary K-Ar ages. These K-Ar ages (as young as 17-18 Ma) were interpreted to indicate late movement along spatially related thrust faults (Lee and others, 1970; and Lee, Marvin, and Mehnert, 1980).

These late Precambrian and Early Cambrian quartzites are remarkable for their low contents of CaO and Na_2O, leading Lee and others (1980) to conclude that they were derived from a deeply weathered crystalline terrane. Moreover, U-Th-Pb isotopic studies of monazite and zircon indicate that the original sands were derived from a crystalline terrane of early Proterozoic age (1,726±26 Ma), and, at least in the Hampton Creek area of the northern Snake Range, were affected by a Late Cretaceous (78±9 Ma) metamorphic event (Lee and Fischer, 1985).

In addition to the K-Ar age work noted above, chemical and stable isotope data have been presented for many of the metamorphic micas recovered from late Precambrian and Early Cambrian quartzites of eastern Nevada (Lee and others, in press). These same writers note that we still do not have a very good understanding of the timing and conditions of the metamorphic events that have affected these metaclastic rocks, despite the many age, chemical and stable isotope data that have been assembled for the rocks and their constituent micas.

The purpose of this paper is to present $\delta^{18}O$ values for 31 quartzites collected from eastern Nevada and nearby areas (see fig. 1). Almost all of these same quartzites are discussed in one or more of the papers already cited. The analytical methods used in this study are those described by Friedman and O'Neil (1977).

Analytical Results

The 31 quartzites in table 1 have $\delta^{18}O$ values that range between +9.7 permil and +15.6 permil, though 26 values fall between +10.5 mil and +12.9 mil. It is notable that three of the four highest values in table 1 (samples 472, 474, and 499) represent Precambrian quartzites collected within an area of only about 3 km^2 in the southern Snake Range (fig. 1).

Oxygen isotope fractionation data for quartz-muscovite pairs recovered from 12 of the quartzites in table 1 are listed in table 2, with temperatures, based on Δ (quartz-muscovite), taken from curve B, figure 24 of Friedman and O'Neil (1977). Such data as those listed in table 2 are potentially useful for oxygen isotope thermometry if it can be demonstrated that the rocks in question have been recrystallized. Some of the rocks in table 2 (numbers 503, 506, and 561) were collected beneath the sole of the Snake Range decollement. Others (numbers 547, 548, and 549) are staurolite-grade

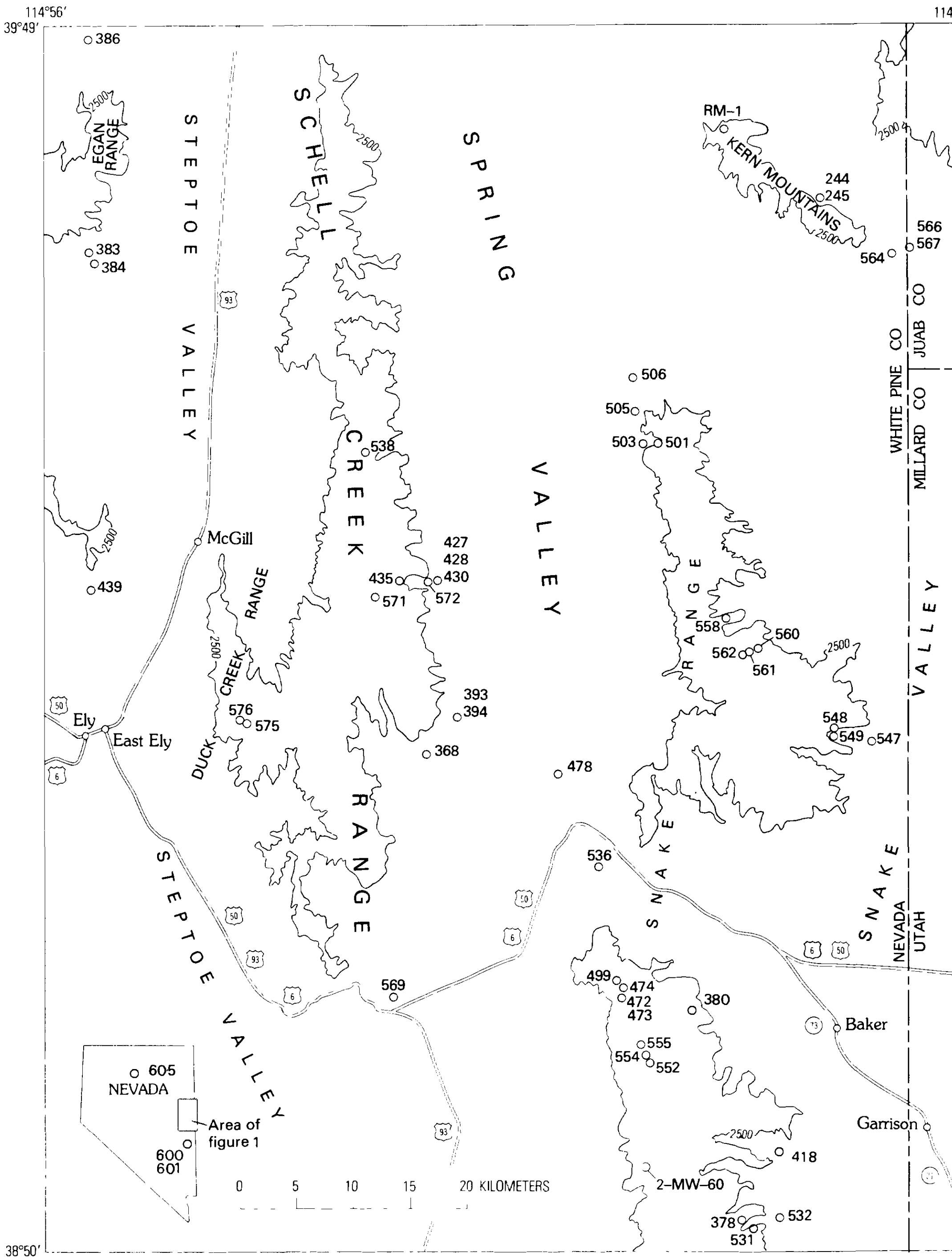

Figure 1.--Map of part of eastern Nevada and western Utah, showing sample localities. Sample locality 471 is about 50 km east of the map area. The 2,500-m contour lines are not shown in the southwestern part of the map area.

metamorphic rocks. In both these environments the rocks have indeed recrystallized, and most of the other samples in table 2 also appear to have recrystallized. Petrographic descriptions and additional discussion of almost all of the samples in table 2 are presented by Lee, Marvin, and Mehnert (1980).

Uses of Data

The information in table 1 might be useful in deducing the possible effects of assimilation or anatexis of these quartzites on plutonic rocks spatially related to them. See for example the discussion of Lee and Christiansen (1983). Moreover, as more stable isotope data of this type accumulates, the information in table 1 might be useful in our attempts to understand other aspects of the history of eastern Nevada.

Aside from the question of whether or not the rocks have completely recrystallized, the present usefulness of the information in table 2 is restricted by experimental difficulties and nonequilibrium effects related to the data on which ^{18}O fractionation versus temperature curves are based. These problems are discussed by Friedman and O'Neil (1977). The temperatures inferred in table 2 are not obviously incompatible with the little that we know about metamorphism in the area of eastern Nevada. The Late Cretaceous metamorphic event recognized in the Hampton Creek area of the northern Snake Range (samples 547, 548, and 549) involved the development of staurolite and kyanite, indicating temperatures above 500°C (Heitanen, 1967, fig. 1; Winkler, 1974, fig. 14-1).

Monazite was also formed during the Late Cretaceous metamorphism of the Hampton Creek sediments, and scattered grains of similar (metamorphic) monazite coexist with most of the other quartz-muscovite pairs listed in table 2 (Lee and Fischer, 1985). In other words, although there is direct geologic evidence for temperatures above 500°C only in the Hampton Creek area, the other samples in table 2 have also been metamorphosed, and it is possible that the temperatures deduced from Δ (quartz-muscovite) values may be significant.

Conclusions

The oxygen isotope data presented in tables 1 and 2 may be useful in directing future studies of the igneous and metamorphic rocks of eastern Nevada, but the inferred temperatures listed in table 2 must be regarded as preliminary and tentative.

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Table 1.--The oxygen isotope composition of selected quartzites of White Pine County, Nevada, and nearby areas

Sample	Latitude N.			Longitude W.			Rock type[1]	^{18}O (SMOW)
	°	′	″	°	′	″		
380 [2]	39	01	20	114	16	11	pЄЄpm	10.6 permil
418 [2]	38	54	48	114	10	50	"	11.8
428 [2,3,5]	39	22	30	114	31	25	pЄ	12.0
430 [3]	39	22	26	114	31	40	"	14.6
435 [3]	39	22	21	114	34	08	"	10.7
439 [3]	39	22	13	114	52	58	pЄЄpm	12.5
446 [4]	41	58	50	113	51	40	pЄh	11.3
471 [3]	39	14	55	113	25	40	Єp	10.6
472 [3]	39	02	20	114	20	25	pЄpw	13.3
473 [3]	39	02	20	114	20	25	"	12.3
474	39	02	46	114	20	03	pЄw	13.9
478 [3,5]	39	13	00	114	24	35	pЄЄpm	9.7
499 [3]	39	03	05	114	20	45	pЄstr	15.6
501 [3,5]	39	29	00	114	18	10	Єp	12.3
503 [2,3,5]	39	29	05	114	19	10	pЄЄpm	11.9
506 [2,3,5]	39	22	55	114	19	45	"	11.9
536 [3]	39	08	35	114	22	00	pЄstr	11.1
538 [3]	39	28	19	114	37	00	Єp	12.2
547 [2,3,5]	39	14	35	114	04	50	pЄЄpm	10.8
548 [2,3,5]	39	15	15	114	07	15	"	10.8
549 [2,3,5]	39	14	55	114	07	10	"	12.7
555 [3,5]	39	00	05	114	19	15	"	11.8
558 [2,3]	39	20	35	114	14	05	Єp	11.5
561 [3,5]	39	19	00	114	12	35	pЄЄpm	10.9
569 [2,3,5]	39	02	22	114	34	09	"	10.5
571 [3]	39	21	36	114	35	36	"	11.1
575 [3]	39	15	32	114	43	43	"	11.1
576 [3]	39	15	36	114	44	02	Єp	11.9
600	37	55	36	114	23	06	pЄЄpm	12.1
601	37	56	24	114	25	34	pЄЄpm	12.9
605	40	53	44	117	14	00	Єom	12.8

[1]pЄЄpm, Precambrian and (or) Cambrian Prospect Mountain Quartzite. Єp, Cambrian Pioche Shale. pЄpw, unnamed Precambrian unit [pre-Willard Creek Quartzite of Misch and Hazzard (1962)]. pЄstr, Precambrian Strawberry Creek Formation of Misch and Hazzard (1962). pЄ, Precambrian McCoy Creek Group of Misch and Hazzard (1962). pЄh, Precambrian Harrison Formation. Єom, Cambrian Osgood Mountain Quartzite.

[2]Included in the study by Lee, Van Loenen, Brandt, and Doering (1980).

[3]Included in the study by Lee, Marvin, and Mehnert (1980).

[4]Included in the study by Lee and Marvin (1981).

[5]Included in the study by Lee, Van Loenen, Brandt, and Gleason (in press).

Table 2.--Temperatures based on intermineral oxygen isotope fractionations between quartz and muscovite recovered from selected quartzites of White Pine County, Nevada, and nearby areas

Sample Number	$\delta^{18}O$ Quartz (permil)	$\delta^{18}O$ Muscovite (permil)	Δ (Quartz-muscovite)	Temperature[1]
380	10.2	7.5	2.7	542°C
418	11.8	8.4	3.4	470
428	14.0	10.8	3.2	490
446	11.9	8.4	3.5	460
478	10.8	8.0	2.8	530
503	11.9	8.8	3.1	500
506	10.5	8.8	1.7	700
547	11.0	9.3	1.7	700
548	11.2	8.9	2.3	595
549	13.0	10.5	2.5	570
555	12.1	10.3	1.8	680
561	11.9	8.4	3.5	460

[1]Temperatures taken from curve B, figure 24 of Friedman and O'Neil (1977).