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the southwest, an influx of nonmarine sediments advanced from the southeast building a deltaic wedge into southern Ohio and thereby splitting the Brush Creek Limestone into an upper and lower member. Detailed mapping of the Brush Creek wedge shows that peat and black mud accumulated in back-swamps between delta distributaries. Crevasse silts were deposited over the peat where natural levees periodically broke. Prodelta muds were deposited at the delta front, and penecontemporaneous black chert accumulated within interdistributary bays. At least two stages of development are evident in the formation of the deltaic wedge. The Brush Creek sea was probably not more than 60 feet deep.

Many coal swamp drainage systems initially were established during the period of sand and underclay deposition prior to the formation of coal seams, and prevailed with little change through the period of peat accumulation. The geometry of coal facies shows paleostreams were bordered by natural levees and in some places cannel coal formed behind the levees.

Mapping was done on a 1:500,000 scale and approximately 4000 control points were utilized in constructing the environmental maps.

### K/Rb Fractionation in the Kiglapait Layered Intrusion

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Eight rocks from the Kiglapait intrusion, Labrador, were analyzed by isotope dilution for K and Rb. The samples range from troctolite at the 82 per cent solidified level to fayalite ferrosyenite at the 100 per cent solidified level. Percentage of K ranges from .09 to 2.10 ppm, and Rb ranges from 1.0 to 15.6 ppm.

K/Rb ratios, in ascending stratigraphic order, are 740, 910, 1410, 1830, 1580, 1390, 2190, and 1340,  $\pm 100$  maximum.

When K/Rb is plotted against log K, five of the points are nearly colinear and show a strongly increasing K/Rb ratio with fractionation. A sixth (K/Rb = 1340) may represent a change toward decreasing ratios in the last liquids; the rock is a two-feldspar syenite, whereas the other upper rocks are mesoperthite syenites. Two of the points lie far off the trend for reasons not yet understood.

The Kiglapait is a Precambrian example of extreme closed-system fractionation; it is well exposed and affords good stratigraphic control for trace- and major-element studies. Familiar trends of decreasing K/Rb (*e.g.*, oceanic volcanic rocks) are not followed by this deep-seated intrusion. The change in ratios is apparently not due to exhaustive removal of Rb by lower rocks because Rb content increases upward. It may therefore be due to exclusion of Rb from slowly growing feldspars and consequent enrichment of Rb in the last liquid.

The data underline the importance of understanding the various mechanisms of K/Rb fractionation before extrapolating from K/Rb trends to models of mantle and bulk-earth geochemistry.

### Nissonite, $\text{CuMg}(\text{PO}_4)(\text{OH}) \cdot 2\frac{1}{2}\text{H}_2\text{O}$ , a New Hydrous Copper Magnesium Phosphate Mineral from the Panoche Valley, California

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Nissonite, a new hydrous copper magnesium phosphate mineral,  $\text{CuMg}(\text{PO}_4)(\text{OH}) \cdot 2\frac{1}{2}\text{H}_2\text{O}$ , occurs in a small copper prospect in metamorphic rocks of the Franciscan Formation in

Panoche Valley, California. Associated minerals include malachite, azurite, libethenite, turquoise, chrysocolla, cuprite, barite, calcite, gypsum, riebeckite, and crossite. The copper mineralization appears to be postmetamorphic.

Nissonite occurs rarely as minute diamond-shaped crystals and more abundantly as thin bluish-green (Ridgway's tyrolite green) crusts of crystal aggregates. The crystals are monoclinic,  $C2/c$  or  $Cc$ ,  $a = 22.58 \text{ \AA}$ ,  $b = 5.027 \text{ \AA}$ ,  $c = 10.514 \text{ \AA}$ ,  $\beta = 99^\circ 20'$ , cell volume  $1177.6 \text{ \AA}^3$ . The X-ray diffraction powder pattern shows the following strong lines ( $hkl$ ,  $d_{hkl}$ ,  $I$ ): 200,  $11.14 \text{ \AA}$  (100); 800,  $2.785 \text{ \AA}$  (25); 111,  $4.374 \text{ \AA}$  (21); 600,  $3.716 \text{ \AA}$  (15); 312,  $3.111 \text{ \AA}$  (11);  $\bar{6}23$ ,  $1.860 \text{ \AA}$  (11). Crystals of nissonite are tabular  $\{100\}$  and elongated  $[001]$ ; observed forms are  $c\{001\}$ ,  $a\{100\}$ , and  $q\{\bar{1}11\}$ . The mineral has hardness  $2\frac{1}{2}$  and fair cleavage (100). Nissonite is easily soluble in dilute acids. Density calculated for eight formula units per cell is  $2.74 \text{ g cm}^{-3}$ ; density measured,  $2.73 \pm 0.01 \text{ g cm}^{-3}$ . Nissonite is biaxial with  $(- )2V_\alpha$  (calc.) =  $19^\circ$ , dispersion  $r > v$ , very strong;  $X \wedge a = +15^\circ$ , colorless,  $\alpha = 1.584 \pm 0.002$ ;  $Z = b$ , turquoise-blue,  $\beta = 1.620 \pm 0.002$ ;  $Y \wedge c = +6^\circ$ , turquoise-blue,  $\gamma = 1.621 \pm 0.002$ .

Chemical analysis of a 200-mg sample gave the following results in weight per cent: CuO 32.2, MgO 15.8,  $\text{Fe}_2\text{O}_3$  0.04,  $\text{P}_2\text{O}_5$  27.1,  $\text{V}_2\text{O}_5$  0.2,  $\text{H}_2\text{O}^+$  16.8,  $\text{H}_2\text{O}^-$  5.6, acid insoluble 1.4 (= barite), total 99.14, corresponding to  $\text{CuMg}(\text{PO}_4)(\text{OH}) \cdot 2\frac{1}{2}\text{H}_2\text{O}$ .

The new mineral is named for William H. Nisson (1912–1965), amateur mineralogist of Petaluma, California, whose preliminary microchemical tests on this mineral characterized it as a probable new copper magnesium phosphate. The name has been approved by the Commission on New Minerals and Mineral Names, I.M.A.

### Synthesis and Properties of Fairchildite and Buetschliite: Their Relation in Wood-Ash Stone Formation

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Composition, crystallography, and synthesis of fairchildite and buetschliite indicate that these two minerals are high- and low-temperature polymorphs, respectively, of  $\text{K}_2\text{Ca}(\text{CO}_3)_2$ . Fairchildite and buetschliite were described by Milton and Axelrod in 1947 from wood-ash clinkers formed during forest fires in western United States.

Fairchildite was synthesized from equimolar amounts of  $\text{K}_2\text{CO}_3$  and  $\text{CaCO}_3$  in closed, but not sealed, carbon crucibles in the temperature range  $704^\circ\text{--}970^\circ\text{C}$ ; buetschliite, in the temperature range  $593^\circ\text{--}704^\circ\text{C}$ . Buetschliite also was formed at room temperature from a 40 per cent solution of  $\text{K}_2\text{CO}_3$  containing calcite; doubly terminated single crystals formed from such solution kept in a flask for 4 days at  $54^\circ\text{C}$ . At room temperature fairchildite keeps indefinitely in a desiccator. When exposed to the atmosphere, fairchildite converted slowly to buetschliite. A water-saturated atmosphere hastened the conversion; on further exposure buetschliite acquired hygroscopic water and dissolved incongruently leaving calcite. Conversion to fairchildite occurs upon heating buetschliite in a closed, but not sealed, carbon crucible at least as low as  $704^\circ\text{C}$ . Analyses of fairchildite and buetschliite lead to the same formula,  $\text{K}_2\text{Ca}(\text{CO}_3)_2$ . The small amount of water found in buetschliite ( $\text{H}_2\text{O}^+$  1.01 per cent,  $\text{H}_2\text{O}^-$  0.04 per cent) apparently has no constitutional significance.

Fairchildite is hexagonal with space group  $P6/mmc$ ,  $P6mc$ , or  $P\bar{6}2c$ ;  $a = 5.29 \text{ \AA}$ ,  $c = 13.32 \text{ \AA}$ ;  $Z = 2$ ;  $D_m = 2.446 \text{ g/cm}^{-3}$ ,  $D_c = 2.45 \text{ g/cm}^{-3}$ . Buetschliite is trigonal, space group  $R\bar{3}$ ;  $a = 5.38 \text{ \AA}$ ,  $c = 18.12 \text{ \AA}$ ;  $Z = 3$ ;  $D_m = 2.601 \text{ g/cm}^{-3}$ ,  $D_c = 2.61 \text{ g/cm}^{-3}$ .

Fairchildite formed during forest fires. Buetschliite formed later by recrystallization from fairchildite in strong (at least 40 per cent) KOH solutions derived by the leaching of potash from the charred tree trunks during rainstorms; reaction with less concentrated solutions produced the calcite sometimes found associated with fairchildite and buetschliite.