

DISCUSSION

Introduction

Examination of serpentine mineralogy, rock density, and magnetic susceptibility of rocks from the Kalmiopsis Wilderness was conducted as part of the evaluation of the mineral resources of the area. The density and magnetic susceptibility data from the rocks from the base for gravity and magnetic mapping and also give an approximation of the degree of serpentinization of the rocks. The density and magnetic susceptibility data are superimposed on a geological map from Page and others (1981), who also collected the rock samples.

Techniques

Density measurements were determined by weighing 522 rock samples in water and air; 233 samples were serpentinized or partially serpentinized ultramafic rocks. Page (1967) and Coleman (1971) showed that the degree of serpentinization is directly proportional to density. A density of 2.55 g/cm³ or greater represents rocks (dunite, peridotite, or pyroxenite) composed of essentially fresh olivine, pyroxene, or both; a density of 2.55 g/cm³ or less represents rocks composed of varying degrees of serpentinized olivine and pyroxene. Completely serpentinized rocks have densities of 2.55 g/cm³ or less (Fig. 1). The degree of serpentinization, about 200 samples were selected for mineralogical examination, and a part of each rock sample (10 to 100 g) was crushed to a fine powder (100 mesh); the magnetic material was removed with a bar magnet, and bromine (0.5-2.0 ml) was used to separate light and heavy nonmagnetic minerals. After drying, the light nonmagnetic fraction was removed by a 5-cc differential using a soil puck, color radiation and a nickel filter, and a scan speed of 1°/26 min.

The completed X-ray chart was compared to X-ray diffraction mineral patterns including antigorite, clinochrysotile, lizardite, brucite, talc, chrysotile, and talc. These standards, which were developed from relatively pure samples (Page and Coleman, 1971), were used to determine the type(s) of serpentine minerals present. The results of the mineralogical examination are printed on the maps (Fig. 1). The magnetic susceptibility measurements were made with a susceptibility bridge.

Results

The degree of serpentinization of ultramafic rocks from the area ranges from 100 percent to completely fresh unserpentinized rock (Fig. 1), more than 50 percent of the rocks are more than 75 percent serpentinized, and only about 4 percent are less than 25 percent serpentinized. The degree of serpentinization appears to increase in the south. In the northern part of the Kalmiopsis area that is underlain by the Josephine Belt, the degree of serpentinization is greater near thrust and normal faults; however, the density data indicate a band of generally weakly serpentinized ultramafic rocks along the northern part of the Josephine Belt. The degree of serpentinization in the northwestern area where tectonic and ultramafic complexes of peridotite and gabbro are present, the degree of serpentinization appears to be related spatially to faulting and to proximity of intrusions of hornblende gabbro, tonalite, and diorite.

In 99 percent of the rocks examined by X-ray diffraction, lizardite and clinochrysotile are the common minerals, accompanied by antigorite and talc. Olivine, orthopyroxene, clinopyroxene, and chromite occur in 34 percent of the samples. The spatial distribution of brucite, talc, and chrysotile has no apparent pattern.

Previous studies of the effect of serpentinization on the magnetic properties of ultramafic rocks (for example, Reid, 1969) show an increase in magnetic susceptibility with increasing serpentinization. In the density range from 2.55 to 2.50 g/cm³, the magnetic susceptibility of the rocks is relatively constant, and the density range from 2.55 to 2.50 g/cm³ is considered as a single group. However, a correlation very similar to that observed by Reid (1969) does exist for the 75 percent samples. The linear regression line on the log electromagnetic unit versus density plot for the peridotite alone is

$$\log_{10} X = -0.022 + 11.4 \rho$$

where X is susceptibility in electromagnetic units and ρ is density in grams per cubic centimeter.

These density and susceptibility measurements provide important constraints to geophysical model studies of the Kalmiopsis Wilderness Area (Blakely and Page, 1980).

References Cited

- Blakely, R. J., and Page, N. J., 1980, Interpretation of aeromagnetic data over the Kalmiopsis Wilderness, southwestern Oregon, and implications for marine magnetic anomalies: *BGS, Transactions of the American Geophysical Union*, v. 61, p. 897-910.
- Coleman, R. G., 1971, Petrologic and geophysical nature of serpentinized ultramafic rocks: *Journal of Petrology*, v. 12, p. 321-342.
- Page, N. J., 1967, Serpentinization at Mount Kalmiopsis, California: *Geological Society of America Bulletin*, v. 82, p. 897-910.
- Page, N. J., and Coleman, R. G., 1971, Serpentinization of ultramafic rocks: *Journal of Petrology*, v. 12, p. 321-342.
- Page, N. J., Goff, F., Goff, J., Goff, R., Goff, S., Goff, T., Goff, U., Goff, V., Goff, W., Goff, X., Goff, Y., Goff, Z., Goff, AA, Goff, AB, Goff, AC, Goff, AD, Goff, AE, Goff, AF, Goff, AG, Goff, AH, Goff, AI, Goff, AJ, Goff, AK, Goff, AL, Goff, AM, Goff, AN, Goff, AO, Goff, AP, Goff, AQ, Goff, AR, Goff, AS, Goff, AT, Goff, AU, Goff, AV, Goff, AW, Goff, AX, Goff, AY, Goff, AZ, Goff, BA, Goff, BB, Goff, BC, Goff, BD, Goff, BE, Goff, BF, Goff, BG, Goff, BH, Goff, BI, Goff, BJ, Goff, BK, Goff, BL, Goff, BM, Goff, BN, Goff, BO, Goff, BP, Goff, BQ, Goff, BR, Goff, BS, Goff, BT, Goff, BU, Goff, BV, Goff, BW, Goff, BX, Goff, BY, Goff, BZ, Goff, CA, Goff, CB, Goff, CC, Goff, CD, Goff, CE, Goff, CF, Goff, CG, Goff, CH, Goff, CI, Goff, CJ, Goff, CK, Goff, CL, Goff, CM, Goff, CN, Goff, CO, Goff, CP, Goff, CQ, Goff, CR, Goff, CS, Goff, CT, Goff, CU, Goff, CV, Goff, CW, Goff, CX, Goff, CY, Goff, CZ, Goff, DA, Goff, DB, Goff, DC, Goff, DD, Goff, DE, Goff, DF, Goff, DG, Goff, DH, Goff, DI, Goff, DJ, Goff, DK, Goff, DL, Goff, DM, Goff, DN, Goff, DO, Goff, DP, Goff, DQ, Goff, DR, Goff, DS, Goff, DT, Goff, DU, Goff, DV, Goff, DW, Goff, DX, Goff, DY, Goff, DZ, Goff, EA, Goff, EB, Goff, EC, Goff, ED, Goff, EE, Goff, EF, Goff, EG, Goff, EH, Goff, EI, Goff, EJ, Goff, EK, Goff, EL, Goff, EM, Goff, EN, Goff, EO, Goff, EP, Goff, EQ, Goff, ER, Goff, ES, Goff, ET, Goff, EU, Goff, EV, Goff, EW, Goff, EX, Goff, EY, Goff, EZ, Goff, FA, Goff, FB, Goff, FC, Goff, FD, Goff, FE, Goff, FF, Goff, FG, Goff, FH, Goff, FI, Goff, FJ, Goff, FK, Goff, FL, Goff, FM, Goff, FN, Goff, FO, Goff, FP, Goff, FQ, Goff, FR, Goff, FS, Goff, FT, Goff, FU, Goff, FV, Goff, FW, Goff, FX, Goff, FY, Goff, FZ, Goff, GA, Goff, GB, Goff, GC, Goff, GD, Goff, GE, Goff, GF, Goff, GH, Goff, GI, Goff, GJ, Goff, GK, Goff, GL, Goff, GM, Goff, GN, Goff, GO, Goff, GP, Goff, GQ, Goff, GR, Goff, GS, Goff, GT, Goff, GU, Goff, GV, Goff, GW, Goff, GX, Goff, GY, Goff, GZ, Goff, HA, Goff, HB, Goff, HC, Goff, HD, Goff, HE, Goff, HF, Goff, HG, Goff, HH, Goff, HI, Goff, HJ, Goff, HK, Goff, HL, Goff, HM, Goff, HN, Goff, HO, Goff, HP, Goff, HQ, Goff, HR, Goff, HS, Goff, HT, Goff, HU, Goff, HV, Goff, HW, Goff, HX, Goff, HY, Goff, HZ, Goff, IA, Goff, IB, Goff, IC, Goff, ID, Goff, IE, Goff, IF, Goff, IG, Goff, IH, Goff, II, Goff, IJ, Goff, IK, Goff, IL, Goff, IM, Goff, IN, Goff, IO, Goff, IP, Goff, IQ, Goff, IR, Goff, IS, Goff, IT, Goff, IU, Goff, IV, Goff, IW, Goff, IX, Goff, IY, Goff, IZ, Goff, JA, Goff, JB, Goff, JC, Goff, JD, Goff, JE, Goff, JF, Goff, JG, Goff, JH, Goff, JI, Goff, JJ, Goff, JK, Goff, JL, Goff, JM, Goff, JN, Goff, JO, Goff, JP, Goff, JQ, Goff, JR, Goff, JS, Goff, JT, Goff, JU, Goff, JV, Goff, JW, Goff, JX, Goff, JY, Goff, JZ, Goff, KA, Goff, KB, Goff, KC, Goff, KD, Goff, KE, Goff, KF, Goff, KG, Goff, KH, Goff, KI, Goff, KJ, Goff, KK, Goff, KL, Goff, KM, Goff, KN, Goff, KO, Goff, KP, Goff, KQ, Goff, KR, Goff, KS, Goff, KT, Goff, KU, Goff, KV, Goff, KW, Goff, KX, Goff, KY, Goff, KZ, Goff, LA, Goff, LB, Goff, LC, Goff, LD, Goff, LE, Goff, LF, Goff, LG, Goff, LH, Goff, LI, Goff, LJ, Goff, LK, Goff, LL, Goff, LM, Goff, LN, Goff, LO, Goff, LP, Goff, LQ, Goff, LR, Goff, LS, Goff, LT, Goff, LU, Goff, LV, Goff, LW, Goff, LX, Goff, LY, Goff, LZ, Goff, MA, Goff, MB, Goff, MC, Goff, MD, Goff, ME, Goff, MF, Goff, MG, Goff, MH, Goff, MI, Goff, MJ, Goff, MK, Goff, ML, Goff, MM, Goff, MN, Goff, MO, Goff, MP, Goff, MQ, Goff, MR, Goff, MS, Goff, MT, Goff, MU, Goff, MV, Goff, MW, Goff, MX, Goff, MY, Goff, MZ, Goff, NA, Goff, NB, Goff, NC, Goff, ND, Goff, NE, Goff, NF, Goff, NG, Goff, NH, Goff, NI, Goff, NJ, Goff, NK, Goff, NL, Goff, NM, Goff, NN, Goff, NO, Goff, NP, Goff, NQ, Goff, NR, Goff, NS, Goff, NT, Goff, NU, Goff, NV, Goff, NW, Goff, NX, Goff, NY, Goff, NZ, Goff, OA, Goff, OB, Goff, OC, Goff, OD, Goff, OE, Goff, OF, Goff, OG, Goff, OH, Goff, OI, Goff, OJ, Goff, OK, Goff, OL, Goff, OM, Goff, ON, Goff, OO, Goff, OP, Goff, OQ, Goff, OR, Goff, OS, Goff, OT, Goff, OU, Goff, OV, Goff, OW, Goff, OX, Goff, OY, Goff, OZ, Goff, PA, Goff, PB, Goff, PC, Goff, PD, Goff, PE, Goff, PF, Goff, PG, Goff, PH, Goff, PI, Goff, PJ, Goff, PK, Goff, PL, Goff, PM, Goff, PN, Goff, PO, Goff, PP, Goff, PQ, Goff, PR, Goff, PS, Goff, PT, Goff, PU, Goff, PV, Goff, PW, Goff, PX, Goff, PY, Goff, PZ, Goff, QA, Goff, QB, Goff, QC, Goff, QD, Goff, QE, Goff, QF, Goff, QG, Goff, QH, Goff, QI, Goff, QJ, Goff, QK, Goff, QL, Goff, QM, Goff, QN, Goff, QO, Goff, QP, Goff, QQ, Goff, QR, Goff, QS, Goff, QT, Goff, QU, Goff, QV, Goff, QW, Goff, QX, Goff, QY, Goff, QZ, Goff, RA, Goff, RB, Goff, RC, Goff, RD, Goff, RE, Goff, RF, Goff, RG, Goff, RH, Goff, RI, Goff, RJ, Goff, RK, Goff, RL, Goff, RM, Goff, RN, Goff, RO, Goff, RP, Goff, RQ, Goff, RR, Goff, RS, Goff, RT, Goff, RU, Goff, RV, Goff, RW, Goff, RX, Goff, RY, Goff, RZ, Goff, SA, Goff, SB, Goff, SC, Goff, SD, Goff, SE, Goff, SF, Goff, SG, Goff, SH, Goff, SI, Goff, SJ, Goff, SK, Goff, SL, Goff, SM, Goff, SN, Goff, SO, Goff, SP, Goff, SQ, Goff, SR, Goff, SS, Goff, ST, Goff, SU, Goff, SV, Goff, SW, Goff, SX, Goff, SY, Goff, SZ, Goff, TA, Goff, TB, Goff, TC, Goff, TD, Goff, TE, Goff, TF, Goff, TG, Goff, TH, Goff, TI, Goff, TJ, Goff, TK, Goff, TL, Goff, TM, Goff, TN, Goff, TO, Goff, TP, Goff, TQ, Goff, TR, Goff, TS, Goff, TT, Goff, TU, Goff, TV, Goff, TW, Goff, TX, Goff, TY, Goff, TZ, Goff, UA, Goff, UB, Goff, UC, Goff, UD, Goff, UE, Goff, UF, Goff, UG, Goff, UH, Goff, UI, Goff, UJ, Goff, UK, Goff, UL, Goff, UM, Goff, UN, Goff, UO, Goff, UP, Goff, UQ, Goff, UR, Goff, US, Goff, UT, Goff, UU, Goff, UV, Goff, UW, Goff, UX, Goff, UY, Goff, UZ, Goff, VA, Goff, VB, Goff, VC, Goff, VD, Goff, VE, Goff, VF, Goff, VG, Goff, VH, Goff, VI, Goff, VJ, Goff, VK, Goff, VL, Goff, VM, Goff, VN, Goff, VO, Goff, VP, Goff, VQ, Goff, VR, Goff, VS, Goff, VT, Goff, VU, Goff, VV, Goff, VW, Goff, VX, Goff, VY, Goff, VZ, Goff, WA, Goff, WB, Goff, WC, Goff, WD, Goff, WE, Goff, WF, Goff, WG, Goff, WH, Goff, WI, Goff, WJ, Goff, WK, Goff, WL, Goff, WM, Goff, WN, Goff, WO, Goff, WP, Goff, WQ, Goff, WR, Goff, WS, Goff, WT, Goff, WU, Goff, WV, Goff, WW, Goff, WX, Goff, WY, Goff, WZ, Goff, XA, Goff, XB, Goff, XC, Goff, XD, Goff, XE, Goff, XF, Goff, XG, Goff, XH, Goff, XI, Goff, XJ, Goff, XK, Goff, XL, Goff, XM, Goff, XN, Goff, XO, Goff, XP, Goff, XQ, Goff, XR, Goff, XS, Goff, XT, Goff, XU, Goff, XV, Goff, XW, Goff, XX, Goff, XY, Goff, XZ, Goff, YA, Goff, YB, Goff, YC, Goff, YD, Goff, YE, Goff, YF, Goff, YG, Goff, YH, Goff, YI, Goff, YJ, Goff, YK, Goff, YL, Goff, YM, Goff, YN, Goff, YO, Goff, YP, Goff, YQ, Goff, YR, Goff, YS, Goff, YT, Goff, YU, Goff, YV, Goff, YW, Goff, YX, Goff, YY, Goff, YZ, Goff, ZA, Goff, ZB, Goff, ZC, Goff, ZD, Goff, ZE, Goff, ZF, Goff, ZG, Goff, ZH, Goff, ZI, Goff, ZJ, Goff, ZK, Goff, ZL, Goff, ZM, Goff, ZN, Goff, ZO, Goff, ZP, Goff, ZQ, Goff, ZR, Goff, ZS, Goff, ZT, Goff, ZU, Goff, ZV, Goff, ZW, Goff, ZX, Goff, ZY, Goff, ZZ.

Table 1. Location, density, and magnetic susceptibility of rocks from the Kalmiopsis Wilderness area.

Sample	Latitude	Longitude	Density g/cm ³	Susceptibility 10 ³ emu	Rock type
780001	42-1000	123-9329	2.51	0.18	PE
780004	42-1004	123-9378	2.72	5.55	PE
780005	42-1009	123-9399	2.72	1.92	PE
780009	42-1016	123-9446	2.50	-0.25	PE
780010	42-1013	123-9522	2.50	2.16	PE
780012	42-1050	123-9513	3.00	1.01	PE
780022	42-1226	123-9397	3.11	3.00	PE
780023	42-1223	123-9391	2.72	1.23	PE
780024	42-0898	123-8204	2.67	-0.6	PE
780027	42-0818	123-8339	2.75	-0.0	PE
780028	42-1323	123-8623	2.80	2.68	PE
780030	42-1004	123-9378	2.72	1.92	PE
780040	42-1005	123-9368	2.50	1.50	PE
780042	42-1005	123-9368	2.50	1.50	PE
780054	42-1250	123-8511	3.20	2.06	PT
780061	42-1257	123-8731	3.10	5.57	PT
780070	42-1041	123-9079	3.08	8.50	PE
780081	42-1047	123-8161	2.62	1.41	PE
780089	42-1075	123-9016	2.70	2.48	PE
780094	42-1017	123-9037	3.63	-1.1	CE
780110	42-1009	123-9329	3.00	-0.6	PE
780111	42-1008	123-9410	2.50	2.71	PE
780117	42-1007	123-9005	3.14	-1.39	PE
780136	42-1019	123-9106	2.60	1.72	PE
780138	42-1019	123-9106	2.60	1.72	PE
780096	42-1050	123-9513	2.70	5.51	PE
780094	42-1066	123-9410	2.99	2.73	PE
780170	42-1066	123-9410	2.70	-0.80	PE
780133	42-1038	124-0876	2.75	1.71	PE
780134	42-1030	124-0876	3.05	-1.6	PE
780209	42-1244	123-9197	3.17	6.50	PT
780205	42-1056	124-0284	2.62	2.44	PE
780203	42-1057	124-0283	2.71	7.34	PE
780210	42-0852	123-9019	2.72	2.01	PE
780130	42-1009	124-0900	3.00	-0.5	PE
780213	42-0367	123-9410	2.60	5.49	PE
780012	42-0702	123-9040	2.60	1.44	PE
780018	42-0834	123-9425	2.60	-7.7	PE
780046	42-1067	123-9136	2.71	6.86	PE
780069	42-1069	123-9250	2.63	8.06	PE
780024	42-1042	123-9519	3.22	-0.6	PE
780027	42-1055	123-9514	3.21	-0.31	PE
780032	42-1034	123-9117	2.65	2.67	PE
780040	42-1040	123-9556	2.60	5.45	PE
780098	42-1029	123-9553	2.76	3.94	PE
780001	42-1007	123-9379	2.75	-0.6	PE
780025	42-1010	123-9571	3.06	2.56	PE
780031	42-0896	123-8611	2.61	0.60	PE
780215	42-1021	124-0839	3.24	-1.1	PE
780038	42-1049	124-0721	3.04	4.71	PE

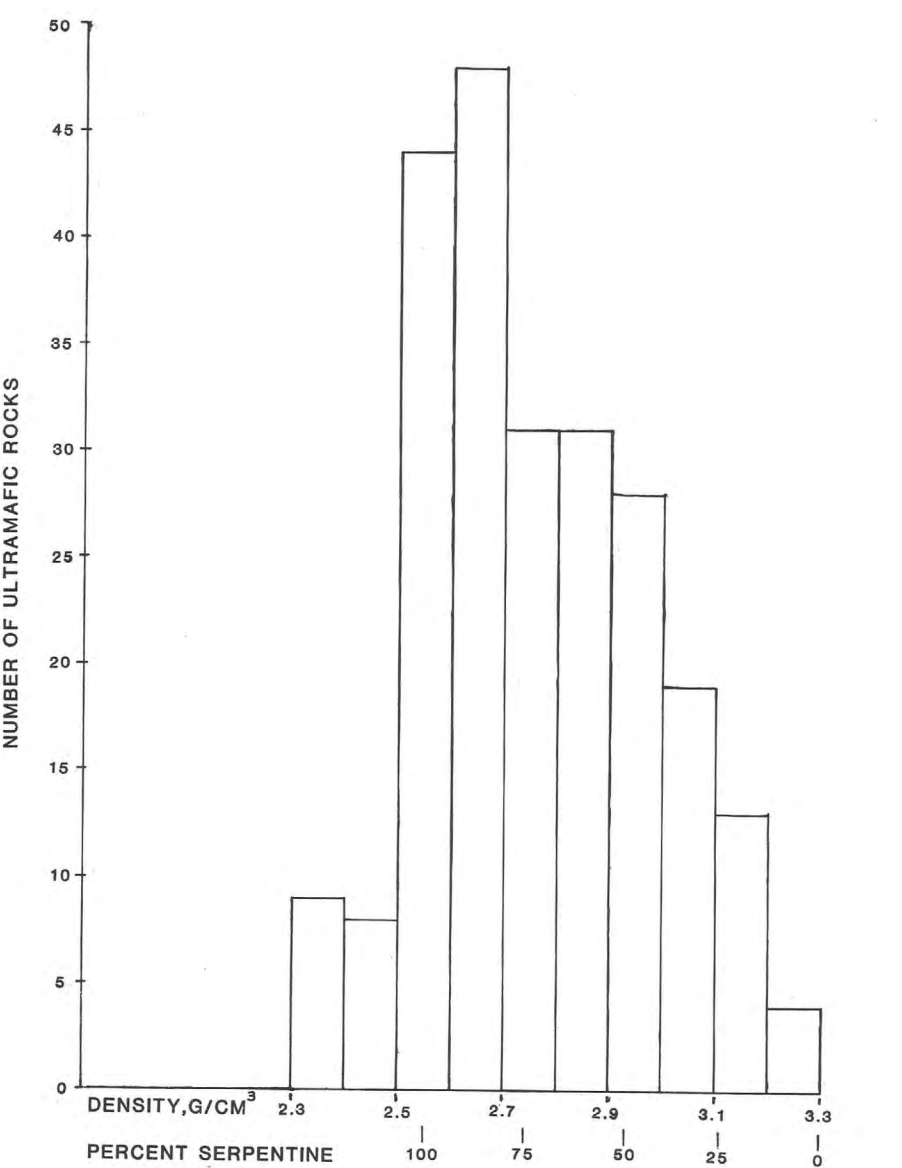


Figure 1. Histogram of density measurements of ultramafic rocks.

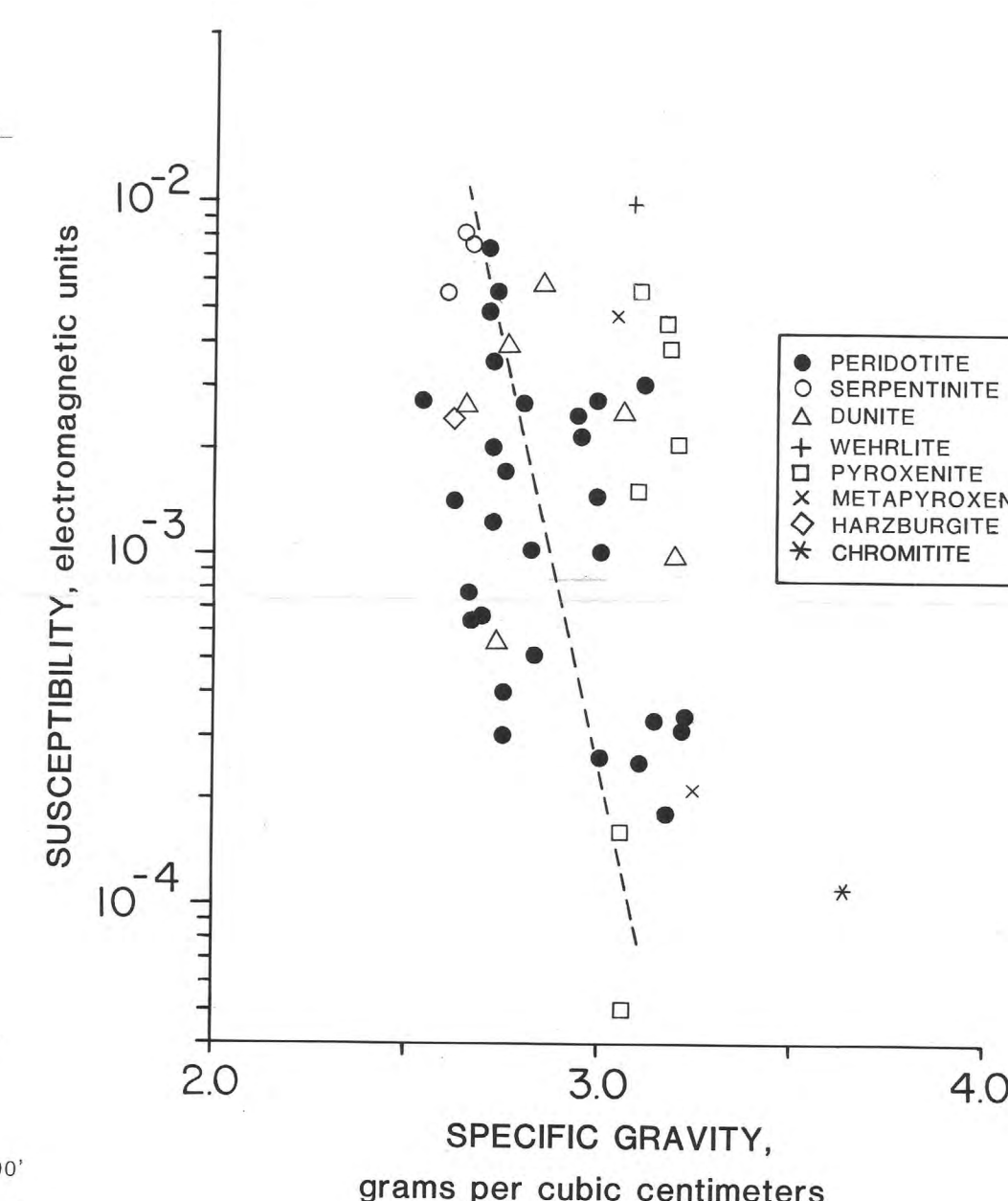


Figure 2. Correlation of magnetic susceptibility with specific gravity of ultramafic rocks.

MAP SHOWING DISTRIBUTION OF SERPENTINE MINERALS, DENSITY, AND MAGNETIC SUSCEPTIBILITY OF ROCKS FROM THE KALMIOPSIS WILDERNESS, SOUTHWESTERN OREGON

By

James B. Barnard, Norman J. Page, Richard J. Blakely, Wayne P. Ziemanski, Craig A. Banister, and James R. Giusso



Studies Related to Wilderness

The Wilderness Act (Public Law 88-577, September 3, 1964) and related Acts, require the Geological Survey and the Bureau of Reclamation to conduct studies to determine the potential for wilderness. Results must be made available to the public and be submitted to the Administration and the Congress. These maps and reports present the results of a geological and mineral survey of the Kalmiopsis Wilderness.

Interior - Geological Survey, Reno, NV - 1981

For sale by Branch of Distribution, U.S. Geological Survey, Box 25286, Federal Center, Denver, CO 80225

