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Paramagnetism of Some Kinds ot Crystalline Schists

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Abstract

In this paper it is mentioned that except several specimens almost all samples of Sambagawa crystalline schists have no clear indication showing existence of ferro or ferrimagnetic minerals therein. Their susceptibility, all being nearly inversely proportional to temperature in the range from 0°C to 600°C, indicates paramagnetic nature. On the other hand, it was found that the susceptibility of those paramagnetic rocks is anisotropic, that is, the susceptibility measured parallel to the lineation of the crystalline schist and that measured perpendicular generally differ from each other.

The rock samples on which the measurements were made are those taken from the so-called Sambagawa crystalline schists in southwestern Japan. They were collected from the vicinity of Mt. KOTSU and the places along the River Yoshino in the eastern Shikoku. The crystalline schists from these regions have such mineral compositions as shown in Table 1.

Table 1. Showing the numbers and constituents of every kind of the rock samples.

Group		Numbers	Mineral composition
Green schist	Actinolite-green schist	15	Albite, actinolite, epidote, titanite (sericite, quartz)*
	Glaucophane-green schist	3	Glaucophane, chlorite, epidote, titanite, (albite, quartz, lawsonite)
Black schist	Black schist	11	Sericite, quartz, brownish-black mineral, albite (garnet, chlorite)
Quartz schist	Piedmontite-quartz schist	5	Piedmontite, quartz, sericite (garnet, braunite)
	Stilpnomelane-quartz schist	2	Stilpnomelane, quartz, calcite (hematite, magnetite)
	Sericite-quartz schist	7	Sericite, quartz (garnet)
Sandstone schist	Sandstone schist	16	Quartz, microcline, albite, pyroxene, clinozoisite, sericite (titanite)

* The minerals in the brackets are rarely found.

Table 2 shows the mean value of intensity of magnetization and of susceptibilitiy in all kinds of the crystalline schists. The intensity of magnetization and its temperature dependency of each specimen (powder sample contained in a small quartz tube with a volume of 0.2 cc) was determined under applied magnetic field of about 3000 Oe at room temperature (20°C) and the mean susceptibility, $\chi_m = M/H$, was obtained.

Several curves showing variation of magnetization with temperature up to 800°C are shown in Fig. 1. These curves are obtained by using spring balance magnetometer under the field of about 3000 Oe in vacuum about 10^{-2}mmHg.

In Fig. 2, the values of magnetic susceptibility of the schists are plotted as a function of the reciprocal of the temperature. The values obey the Curie-Weiss' Law

$$\chi = C/(T-\theta)\,,$$

where χ is susceptibility per gramme, C the Curie constant, T absolute temperature and θ the transition temperature. This indicates the fact that almost all of the crystalline schists are paramagnetic.

Next, by means of KRISHNAN's oscillation method[1], anisotropy in susceptibility was determined. The results show that the susceptibility parallel to the direction of the lineation (χ_1) is largest and that perpendicular to the *s*-surfaces* (χ_3) the smallest.

The difference may be explained to be due to the statistical alignment of constituent minerals in rock whose susceptibilities along their crystal axes differ from each other. The magnetic study of silicate minerals is, therefore, important to understand the observed anisotropy.

Table 2. Intensity of magnetization and mean susceptibility under room temperature and 2600 Oe.

Name	Intensity of magnetization (c.g.s./gr)	Mean susceptibility (c.g.s./gr)
Paramagnetie actinolite-green schist	5.62×10^{-3}	2.18×10^{-6}
Glaucophane-green schist	7.94×10^{-3}	3.68×10^{-6}
Black schist	1.85×10^{-3}	0.71×10^{-6}
Piedmontite-quarzt schist	3.35×10^{-3}	1.26×10^{-6}
Stilpnomelane-quartz schist	2.56×10^{-3}	0.95×10^{-6}
Sericite-quarts schist	2.05×10^{-3}	0.79×10^{-6}
Sandstone schist	1.29×10^{-3}	0.50×10^{-6}

* The term "s-surfaces" is used by SANDER to denote sets of parallel planes of mechanical inhomogeneity in deformed rocks.

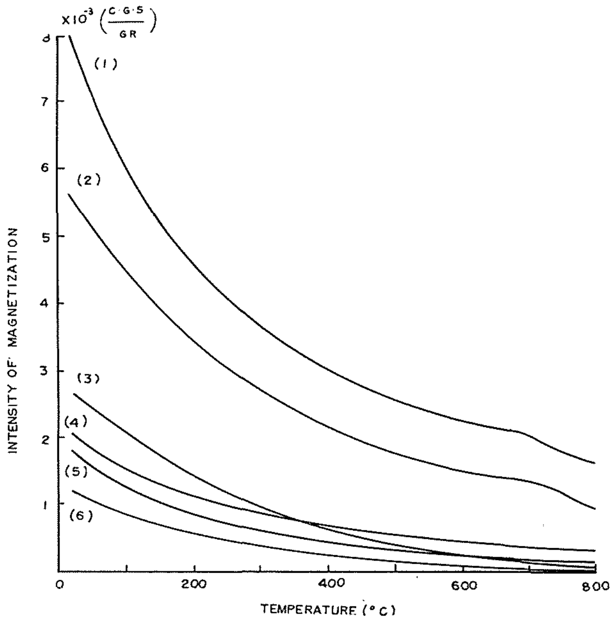

Fig. 1.
(1) Glaucophane green schist
(2) Actinolite green schist
(3) Stilpnomelane quartz schist
(4) Sericite quartz schist
(5) Black schist
(6) Sandstone schist

Table 3. The values of magnetic susceptibility in different directions.
1 : The susceptibility parallel to the direction of the lineation.
2 : The susceptibility perpendicular to the direction of the lineaiion and parallel to *s*-surfaces.
3 : The susceptibtlity perpendicular to the *s*-surfaces.

Name	(1) (c.g.s./gr)	(2) (c.g.s./gr)	(3) (c.g.s./gr)
Paramagnetic actinolite-green schist	3.02×10^{-6}	1.81×10^{-6}	1.72×10^{-6}
Glaucophane-green schist	5.02×10^{-6}	4.59×10^{-6}	1.43×10^{-6}
Black schist	1.30×10^{-6}	0.67×10^{-6}	0.15×10^{-6}
Piedmontite-quartz schist	2.36×10^{-6}	1.31×10^{-6}	0.43×10^{-6}
Stilpnomelane-quartz schist	1.96×10^{-6}	1.27×10^{-6}	0.61×10^{-6}
Sericite-quartz schist	1.47×10^{-6}	0.65×10^{-6}	0.24×10^{-6}
Sandstone-schist	0.80×10^{-6}	0.48×10^{-6}	0.23×10^{-6}

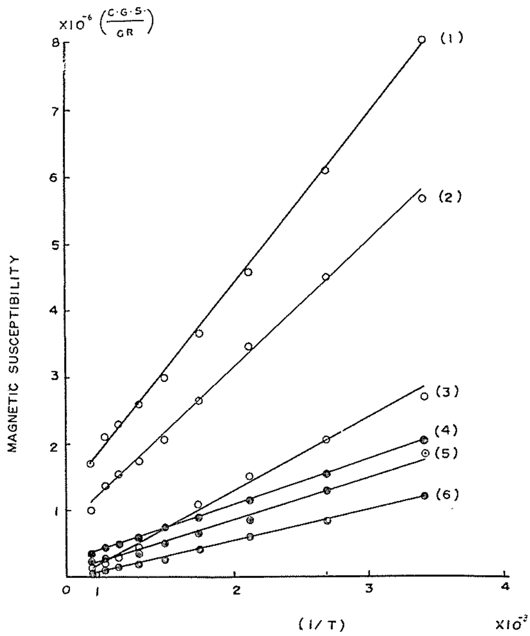

Fig. 2.
(1) Glaucophane green schist
(2) Actinolite green schist
(3) Stilpnomelane quartz schist
(4) Sericite quartz schist
(5) Black schist
(6) Sandstone schist

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Reference

1) K. S. KRISHNAN, B. C. GUHA and S. BANERJEE: Phil. Trans., 231, 235, (1933).