

with dimensions of  $10'' \times 11'' \times 1\frac{1}{4}''$ . Under the microscope the rock is seen to possess a distinct foliation parallel to the broad surface of the slab. All of the columns were cut from this slab with their longer axes parallel to the foliation. In thin sections under the microscope the rock is seen to be composed chiefly of chlorite, talc and dolomite, numerous small crystals and grains of magnetite, and a few grains of pyrite are also present. The two minerals, chlorite and talc, make up by far the greater portion of the rock, the chlorite being somewhat more abundant than the talc. Both occur as plates and sheaflike aggregates, and both possess a very distinct cleavage parallel to which extinction takes place. The dolomite is present both in large rhombohedral individuals and as small irregular granules which possess a linear arrangement parallel to the foliation of the rock. None of the grains of dolomite show either twinning or strain shadows. Having been cut parallel to the foliation, it is not surprising that the columns of this rock employed in the experiments bulged assymmetrically when deformed, and hence a larger number of experiments were made with the steatite than with the other rocks, in order that accurate average results might be secured.

*Slate, New Rockland, Quebec, Canada.*—This is a typical fine-grained slate, black in color, uniform in character, and possessing an excellent cleavage. By means of a diamond drill cores were taken perpendicular to the cleavage of the slate, and from these the columns of slate used in the experiments were prepared.

Under the microscope this slate is found to be composed essentially of minute flakes of two minerals, one of which is apparently kaolin and the other muscovite. In general, the kaolin is much more abundant than the muscovite, from which it can be distinguished in that it possesses a lower double refraction and is not quite so transparent. Within a few extremely narrow bands of the slate the muscovite preponderates. A few minute grains of quartz are interposed between the flakes of muscovite and kaolin. A considerable number of very small flakes of black, opaque, carbonaceous matter, abundant, minute, needle-like crystals of rutile, and a very few widely scattered grains of pyrrhotite are also present. The

rutile crystals are brownish in color and occasionally display the geniculated twinning that is characteristic of this species.

The foliation of the slate explains the lack of symmetry in the expansion of columns of this rock during deformation.

The *Copper* used in these experiments was taken from a rod 1 inch in diameter, representing a good commercial grade of this metal. Prior to being turned into columns for the experiments, the pieces cut from the rod were annealed by being heated to bright redness in the coal fire of a forge, being then allowed to cool down gradually.

The *Lead* employed in the experiments was "assay lead" which, in order to free it from all air bubbles, was melted down and cast in a heated iron mold, which was then allowed to cool slowly.

#### METHODS EMPLOYED

Several long round bars of nickel steel  $2\frac{1}{2}$  inches in diameter, all of identical composition and from the same heat, and all having been submitted to identical treatment in their manufacture, were secured. For these the authors are indebted to the Bethlehem Steel Company, which placed them at their disposal for the purpose of the present investigation.

This steel, which is very uniform in character, possesses a high tensile strength, as well as a high elastic limit, and has the following chemical composition:

Carbon.....	.30 per cent
Manganese.....	.74 per cent
Silicon.....	.162 per cent
Phosphorus.....	.035 per cent
Sulphur.....	.038 per cent
Nickel.....	4.740 per cent

The bars were sawed into lengths of about  $3\frac{1}{4}$  inches. These were then bored and turned into tubes, the longitudinal sections of which, with the final dimensions, are shown in the upper half of Fig. 1. Two sets of these tubes were prepared, differing only in the thickness of the wall of the central portion of the tube. In the first set this has a thickness of 0.33 centimeter, while in the second