

of compression, as is apt to be the case, and this also argues for the late Paleozoic date of the faulting.

### Joints

All the rocks of the region are cut by joints, but they are specially abundant in the Precambrian rocks. Since joints can be formed only in the zone of fracture, their development in these rocks must have been long subsequent to the formation of folds and of foliation, during which interval the rocks had been approaching the surface because of wearing away of what was above. The joints which are found in the Precambrian rocks and not in the overlying paleozoics must be of Precambrian age.

Joints may be produced either by compression or by tension. Those of the latter sort are usually vertical or nearly so, while those of the former may be either vertical or inclined. The simplest case of tension jointing is the production of columnar joint cracks in igneous rocks owing to contraction on cooling. Some of the joints of the dikes of the region are of this class, it being the invariable experience that they are more excessively jointed than are the inclosing rocks. The solidifying and cooling of the great igneous masses of the region, however, took place at such great depths as to be below the zone of fracture, and hence they lack joints of this character, being neither more nor less jointed than are the neighboring gneisses.

Tension joints may also be produced by the desiccation of marine sediments underground, and this cause may have operated somewhat in the production of joints in the Paleozoic rocks, though it is doubtful.

Another very likely cause of the production of tension joints is the slow reduction of temperature brought about in rock masses as they approach the surface because of the slow removal by erosion of the overlying rocks. Though the process is an exceedingly slow one, and the changes of temperature involved are not large, yet, considering the great areal extent of the rocks concerned, the necessary contraction would seem considerable, and likely to much exceed the elastic limit of the rocks.

Where rocks are folded in a complex manner, as is usually the case, torsional effects are sure to be produced, which result in the production of two sets of joints, one running parallel to the axes of the major, and the other to the axes of the minor folds.