Among the various members of the Weesensteiner grauwacke (Devonian) formation is an interesting series of gneissoid rocks between Goppeln and Tronitz. They are feldspathic and full of cordierite, crystals of the latter mineral often attaining great size.

The diabase sheets which generally lie interbedded among the slates and conglomerates are amphibolized, and the diabase tuffs are altered to Actinolite schists.

Further may be mentioned the metamorphic limestones and their associated ore bodies. The chief interest of the region lies in the diversity of the rocks affected by contact metamorphism.

GEOLOGICAL CONFERENCE OF HARVARD UNIVERSITY, NOVEMBER 19, 1895.

Theories of Ocean Currents. By W. M. DAVIS.

The sufficiency of difference of equatorial and polar temperatures to cause a convectional circulation in the ocean has been strongly disputed by many under Croll's leadership, but warmly upheld by others, notably by Carpenter and Ferrel. The following arguments bear on the discussion:

The cross-equator current of the Atlantic, flowing obliquely from the South Atlantic eddy to the North Atlantic eddy, continually carries a great volume of water from one hemisphere to the other. The only available path for its return is as an undercurrent. Assuming that the surface currents are wind-driven, and that there is no other cause for movement of deep waters than wind-driven surface currents, it follows that the movement of the deep Atlantic water should cross the equator from north to south. But the distribution of bottom temperatures shows very clearly that the bottom movement here is from south to north. Hence the assumption that no cause but surface wind is operative cannot be permitted, and the most available other cause is gravitative qonvection.

On the other hand, the annual variation of velocity in the surface currents favors their direct control by surface winds rather than their indirect control by convection, as argued by Ferrel. For, if moving as part of a convectional circulation, they should move fastest when the poleward temperature gradient in the ocean water is strongest; and this is in late summer, when the heat equator of the ocean lies poleward of the geographic equator, and the total difference of equatorial and polar temperatures is found in the minimum distance. But if driven by the winds the surface currents should move fastest in winter, for then the poleward temperature gradient in the atmosphere is strongest and then the winds blow fastest. As far as facts are reported, the eastward surface drift of ocean waters in the temperate zones is strongest in the winter season. The critical point in this argument turns on the essential constancy of temperature in the polar oceans, on account of which the variation of the poleward temperature gradient in the water depends only in the position of the oceanic heat equator; while in the atmosphere the polar temperature changes greatly with the season, and hence, in spite of the greater distance from heat equator to pole in the winter hemisphere, the gradient is then strongest on account of the great winter increase in the polar and equatorial temperature contrast. Oceanic convection should be strongest in the summer hemisphere, but atmospheric convection and wind-driven currents in the winter hemisphere. (Fuller publication in the Proceedings, Boston Society of Nat. Hist.)

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