

geological revolutions. Gradations can sometimes be traced, as in the Penokee district of Wisconsin, from graywackes and slates through every stage of increasing metamorphism into mica-schists which present every appearance of complete original crystallization.<sup>21</sup> The limestones have passed into the condition of marbles; the iron ores, probably originally carbonates, have become oxidized into limonite, hæmatite and magnetite, while the ore has been concentrated into separate masses. The "greenstones" have passed into the condition of true schists.<sup>22</sup> Some of these metamorphosed areas present so many points of resemblance to the lower gneisses already described that it is not at all surprising that they should have been confounded, and that their true relations should only have been made out after much controversy and long-continued detailed study.

A great deal of discussion has arisen as to the true relations of these pre-Cambrian stratified and eruptive rocks to the coarse-crystalline banded gneisses above described. In some sections a complete and strong unconformability occurs between the two series, and no doubt can there exist as to the enormous break that separates them. In other regions, however, the lower gneisses are so involved with schists, limestones, and conglomerates that no satisfactory separation of them has been made, while in some places the gneiss actually crosses these rocks intrusively. Each country or district may present its own phase of the problem. At present we have no means of determining the true correlation of the pre-Cambrian rocks in separate and especially in distant areas. If we admit that the lowest

---

<sup>22</sup> G. H. Williams, Bull. U. S. Geol. Surv. No. 62, 1890.

<sup>21</sup> R. D. Irving and C. R. Van Hise, 10th Ann. Rep. U. S. Geol. Surv. 1890, p. 434.