NO. XXXI.—THE ORIGIN OF GRANITE. By JAMES ANDERSON.

[Read 8th January, 1903.]

(SUMMARY.)

THE author in the first instance contested the generally-accepted theory that granite is of plutonic origin, or, in other words, part of the molten or plastic magma which occupies the interior of the Earth. After referring to the evidences offered in support of this theory, such as the alteration on neighbouring rocks and the arms of granite which penetrate surrounding strata, he pointed out that the great mass of granite in Arran must have reached at one time such an altitude, that had it either been molten or plastic it would have spread itself over the whole island, and filled up Kilbrannau Sound. Its elevation can still be approximately estimated from the rising tangents of the sides of the existing mass. The angle of dip is well seen at several points where it rises not far from the perpendicular, and, prolonging that rise afterwards at a gradually lessening angle, a cone nearly as high as the whole length of Arran would be the result. Without assuming that a perfect cone was ever formed, it is certain that the granite formed an immense mountain before denudation began to wear it down, and that it would not have held together if it had been plastic in the slightest degree.

To arrive at a reasonable view of the origin of granite, it is necessary to begin at a very early stage of the Earth's history. Sir Robert Ball in his latest work, "The Earth's Beginning," attributes the origin of our planet to a circling eddy in a nebula, leaving it to be supposed that this circling went on until it assumed the condition of a molten globe. He does not say that the material forming the nebula was in a molten state, nor does he explain how and when it began to melt. This molten globe figures largely in the works of geological writers, ancient and modern. Sir Archibald Geikie's recently published work on "The Ancient Volcanoes of Great Britain" is entirely based on the

assumption that all active volcanoes have been, and are, fed from the interior molten magma. It may be asked, if that is the case, why is there any difference between granite and any other volcanic product? While providing every volcano with an opening to the seething mass below, Sir Archibald apparently forgets that such an arrangement would not in reality be practicable. The central magma cannot be conceived of otherwise than as a homogenous mass without any divisions, and any tendency to expansion at one corner would spread itself through the whole. If, let us say for argument's sake, an explosive condition could be generated in the molten magma of the interior (and Sir Archibald's theory is that all volcanoes are connected with, and supplied from, this magma), then we should have every volcanic opening on the Earth's surface in active eruption at the same moment. He seems also not to have taken into account that an explosion chamber is a first necessity in the economy of a volcano, just as it is in the case of a gun, and one that could not be provided by the magma, whether molten or plastic.

To keep a volcano in activity, an explosion chamber must be surrounded by substantial rock-walls on all sides. What may be the exact force in operation is an open question, and cannot be dogmatised about, but the suggestion may now be offered that chloritic strata undergoing metamorphism may reach an explosive condition in the course of time. Even more cogent reasons might be given why volcanoes cannot possibly be fed from the central mass of the earth, whatever its condition. The density of its crust is, roughly speaking, only one-third of that of the mass it encloses; therefore the latter would not attempt to rise, even if the crust was perforated all over or reduced to fragments, because the lighter superincumbent mass could not possibly sink into the denser material below.

After discussing the present state of certain of the planetary bodies and pointing out their bearings upon the problem, the author then proceeded to discuss the relationships between granite and the primitive schists, and said, assuming there is a doubt that the foliation of these primitive beds is due to the shrinkage of the Earth, it is at least certain that they are wonderfully different now from their original condition. As they exist they would suffer complete disruption if forced to bend to the slightest

extent. But their foliation shows that they once were as pliable as so many layers, or thicknesses, of cloth. It is further evident, from the unbroken continuity of the bedding throughout each and every fold, that they must have possessed a considerable degree of tenacity and some sort of matted or felted form.

It is impossible now to determine whether the Earth's granitic areas suffered to any extent in the general shrinkage. The material on which the schists rested would yield, and the bosses of granite would thereby be brought to a lower level, but there is not much evidence of crushing having taken place within the masses of granite themselves. The evidence afforded by the existing conditions and the positions of all classes of rock in near contact with granite, shows that the movement of displacement was caused by the sliding downwards of these surrounding rocks while the granite remained passive. Where recent volcanic eruptions have occurred, the enclosing rocks do not show the destructive shattering shown by those which border the granite. The same holds good with all great faults, and it has always been the rock which moved that suffered damage.