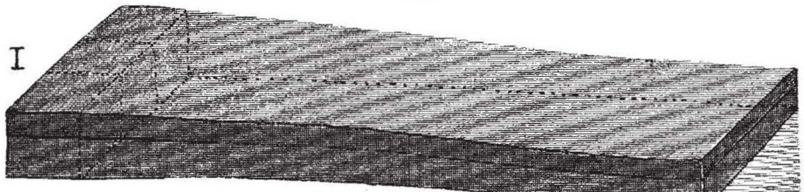
EXPERIMENTS ON FOLDING AND ON THE GENESIS OF MOUNTAIN RANGES.[1]

Method of Investigation; Folding at Different Levels.

DEFORMATION is represented in an exact manner, if we note the movements executed by certain points, and the position of these points before and after deformation. I divide the surface of sediments into squares (scale = 0·1m.), and this division passes in vertical direction through the whole system, so that every stratum is divided into prisms or cubes of known dimensions and positions. At every moment of deformation we may note the movements of any point or line, and the deformation of any square or prism. Especially the deformations of the surface and of normal-profiles is important. The position (orientation) of prisms must agree with the direction of pressure.

FIG. 1.



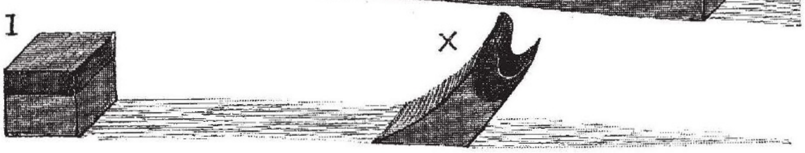


FIG. 2.

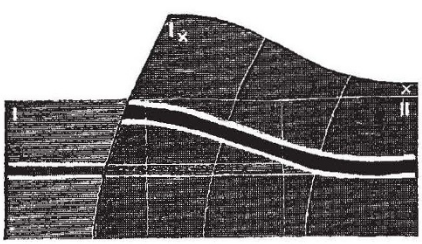


FIG. 3.

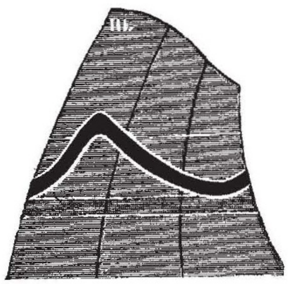


FIG. 4.

FIG. 5.

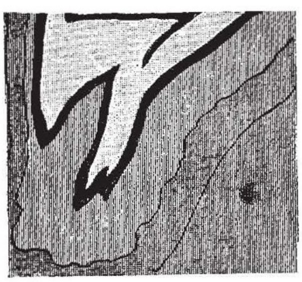
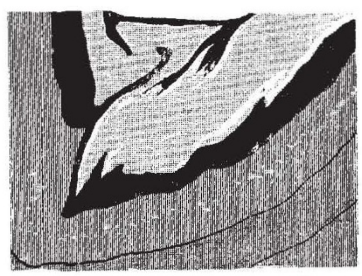


FIG. 6.



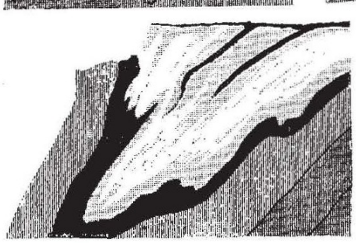


FIG. 7.

FIG. 8.

I employed in every case muddy material (clay, plaster of Paris). Example: We note the position of prism I. in Fig. 1, and its position and deformation are noted in Fig. 2; I. is pushed forward and deformed into I.*x*. B = the "Basal plane," is parallel to the base or surface. No = Normal plane, is situated vertical and in the direction of pressure. L = Longitudinal plane, vertical and at right angles with No, agrees with extension of strata.

N = normals, *i.e.*, perpendicular scale-lines.

Explaining experiments: The sediments I., II., Fig. 3 (exp. 203, clay with a layer of plaster) are subjected to lateral thrust. The higher parts are more moveable and get deformed more than the lower strata.

I. goes to I.*x*, it is compressed and elevated; II. in contact with the wall is elevated a little (to *x*). The dark middle stratum I. produces a flat fold. In Fig. 4 compression and elevation is more intensive. The normals N (originally vertical lines) are deformed into curves.

When at the surface very plastic material dominates (mud), the surface after deformation remains flat, whereas in the deeper parts intense folding may have taken place. If we push a muddy mass, covered by plastic layers, the latter get folded, whereas the deep parts are only thickened.

The movements and deformations of N (normal-profile) are of especial importance.

Fig. 5 (exp. 292), paper between muddy strata. The direction and deformation of normals show the typical movement of strata in each case.

In Fig. 6 a plastic layer (white) lies between muddy sediments. After the deformation only the white layer is folded.

In Fig. 7 folding towards the deeper parts is more intense, but the muddy surface remains flat. In all these cases strata get thickened. The thickness measured in a fold-chain does not correspond to the original thickness. The strata of the Appalachian Mts., having to-day a thickness of 10 km. in a certain section, originally had different dimensions. If measured along the fold-limbs the number is by far too small, as here the strata are rolled out; in the synclines, on the contrary, strata appear much thicker than they were at the beginning.

If plastic sediments are driven by their own weight, *i.e* if they *glide* over an inclined plane against an obstacle.

[1] Extracted from *Geologische und Geographische Experimente*, by Dr. E. Reyer. 1 Heft: Deformation und Gebirgsbildung. Leipzig, 1892. See also "On the Causes of the Deformation of the Earth's Crust," by the same Author. (NATURE, vol. xlvi. p. 224.)

there occurs a deformation, as in the case of lateral pressure. Deformation in the first case is greatest near the obstacle.

Anticlinal Rupture, Pinch-folds, Squeezing, Pseudo-eruptive Processes.

Pushing produces compression. In the anticlines tension effects rupture. In the fold-limbs plastic material is squeezed, rolled out, and pushed towards the clines (synclines or anticlines).

In the synclines of great dimension plastic material is pushed together and pinch-folds result.

Passing over some of the experiments which illustrate the dislocations described by Heim and Margerie we come to more complicated examples.

Figs. 5–8 show "pinch-folds" in very plastic material, which are spread and thrust over, so that they form a flat bottom in the syncline.

Other experiments illustrate a pinch-fold with ruptural deformation. Usually the intense deformation is confined to the district of the pinch-fold; in very plastic material and under variable pressure the stratum in every part gets greatly altered. If we divide the strata into differently coloured prisms we see in each profile at once the deformation at every point. Often deformation is so intense that we may denote it as kneading.

The deformation shows how a vertical dyke gets influenced by folding.

If a plastic stratum is inserted between rigid strata, the former often gets injected into ruptures of the rigid sediments; mud-dykes, pseudo-eruptive processes (Reyer, "Theoret. Geol." p. 330).

Movements of Normals and of Waves. Overthrust, Thrustplanes.[1]

In a fold-chain the higher masses are pushed over the lowland, which does not yield sufficiently. The result is an overthrust, often combined with pinch-folds, Fig. 11 (exp. 207). The inverted strata dip against the direction of the push.

Fig. 9 = original thickness of strata. In Fig. 10 folding begins. Fig. 16 last stage. Normal measure at the base = 1 dm.

In most cases shifting occurs between the strata, especially in upheaved strata, and we see gaping fractures, which cross a stratum and then follow again the planes of stratification (intrusive sheets).

The gliding movement may sometimes cause an extrusion.

Fig. 12 plan, and section Fig. 13 (exp. 278).

An overthrust-fold is nearly squeezed off (compare position of normals). An intense thrust generates ruptures, and the strata glide in the form of scales over the lowland.

Fig. 14 (exp. 242) a fault in the base, over which a complex of sediments glides; the lowland sinks and the higher masses now push with increased force towards the plain ("Vorfaltung": *Suess*).

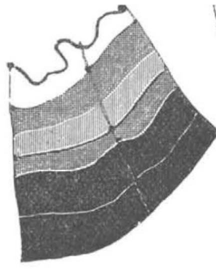
Squeezing and Tearing, Deformation of Included Masses.

Squeezing and tearing often occur in regions of great difference of tension or pressure. In the anticlines strata are torn, the direction of ruptures is converging towards the axes (axipetal direction), in the limbs there occur squeezing and tearing.

[In the latter part of his memoir, Dr. Reyer shows how his experimental methods may be applied to the explanation of such complicated questions as very complicated overthrust faults, the appearances presented when much folded and faulted strata are subjected to erosion, the occurrence of undisturbed tracts associated with much folded ones, and the formation of lake-basins.]

E. REYER.

FIG. 9.



IG. 10.

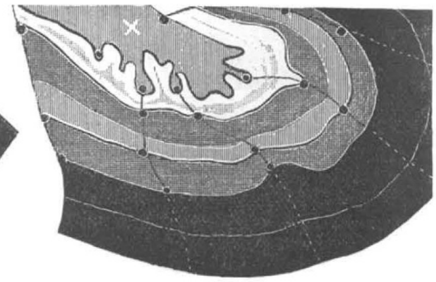
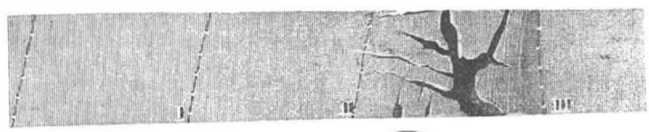


FIG. 11.

FIG. 12.



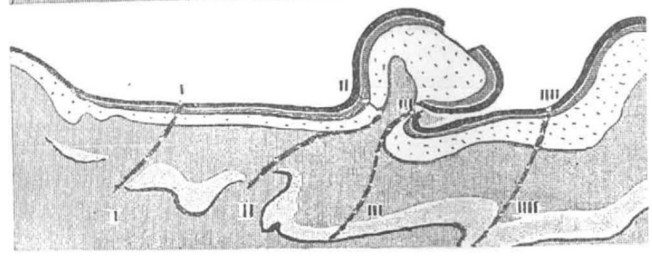


FIG. 13.

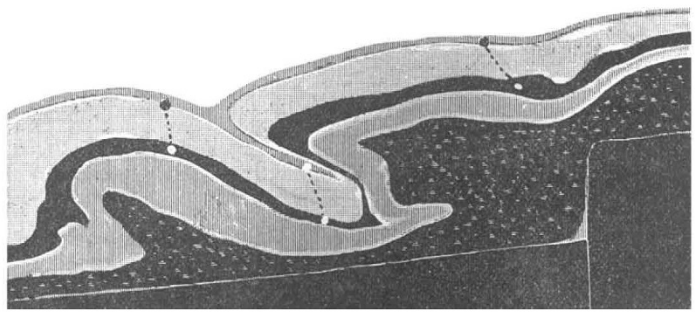


FIG. 14.

[1] Compare the excellent experiments of Forchhammer (Sanddruck, 1883), Cadell (NATURE, vol. xxxvii., p. 489). Those authors experimented with powdery material, whereas I operate upon plastic materials.

GALILEO GALILEI AND THE APPROACHING CELEBRATION AT PADUA.

ALTHOUGH Galileo began his career as a teacher in Pisa, and occupied for three years the Chair of Mathematics there, and was inscribed until his death in the list of the teachers of that University, nevertheless the University of Padua was the one to which from the beginning he had aspired, and in which he exercised with the greatest efficiency his powers as a man of science and