Reprinted for private circulation from
THE JOURNAL OF GEOLOGY, Vol. XLIII, No. 8, Part II, November-December, 1935
PRINTED IN THE U.S.A.

PRELIMINARY NOTE ON A PHYSICAL PHENOMENON RESEMBLING MOUNTAIN-BUILDING

J. A. BROGGI[1]
Lima, Peru

INTRODUCTION

The black waterproof covering of a cinema screen, 1.25 m. square, became so sticky that it could not be rolled, and was hung vertically in a simple U-fold with the coating outside. Under its own weight the coating developed a viscous flow and began to drop off the end of the screen. The coating consisted of a brilliant black viscous underlayer and a dry, dull-black outer surface. The flow was in the lower viscous layer, and developed in the outer layer folds and wrinkles that resembled miniature mountain ranges. Owing to differential movement in the substance, horizontal and vertical tears developed in the outer layer simulating faults in the earth's crust and exposing the underlying viscous layer. Locally the effect was of an "ice pack" of black ice in a black sea. The folds and faults were most abundant near the folded bottom of the screen and decreased upward. Figure 1 shows the phenomena near the bottom and the dripping of the viscous material from the bottom of the folded screen.

THE BLACK COATING

The black waterproof covering was examined by Dr. G. Fester, professor of the Faculty of Industrial and Agricultural Chemistry of Santa Fé, Argentina, and was found to consist of linoxine impregnated with lamp black instead of rubber. Linoxine is a product of polimerization and oxidation of linseed oil and is a solid colloid. If the lacquer is blown with air instead of boiled, it subsequently decomposes, forming lighter organic acids that are liquid and sticky. In this viscous medium the lamp black rises to the surface and forms the dry, dull-black coating.

The viscous layer penetrates between the threads of the muslin cloth of the screen, which are horizontal and vertical and number 96 by 96 to the square inch.

[1] Secretary of the Geological Society of Peru.

THE FLOW

Because of the differences in the thickness of the viscous coating and the degree of its decomposition, the rate and direction of flow

FIG. 1.—Structures produced in decomposed coating of cinema screen

varied, but always with a downward component due to gravity. The adherence of the base to the muslin also caused drag. These differential forces gave rise to the folds and fractures illustrated in Figure 1.

The average daily rate of flow of the surface over a period of 67 days in a room of average temperature of 24° C. was 0.26 mm. The rate of flow was determined by measuring from pins stuck in the screen as markers. The folds bent around the pins in semicircular arcs, owing to a retardation of one-third in the velocity of the flow at the pins. The outer layer generally flowed past the pin without fracturing, showing that it was in a state transitional between solid and liquid. The real distinction between the dull outer layer and the underlying layer is that the outer layer has many more lamp-black particles imbedded in the viscous material than the underlying—a purely physical or mechanical difference which makes it less plastic.

FOLDING

The folds are more numerous and accentuated where there is an obstacle to flow, and they decrease in abundance and become flatter with increasing distance above the obstacle. This phenomenon is seen in Figure 1, in which the folds are more abundant and higher as the flow is retarded by the accumulation of the material at the bottom of the screen.

The amplitude of the folds is generally one-third to one-fourth the thickness of the coating, 0.5–0.4 mm., but in some of the very sharp folds amounts to 1.6 mm., simulating true anticlinoria.

The pattern of the folds reflects the flow of the substratum and the obstacles to that flow.

FAULTING

When differential flow gives rise to tension that exceeds the limit of resistance, true dislocations or faults are produced. They are mainly tension or tear faults parallel to the direction of flow or gravity. Compression faults are rare and occur only in the strongly folded zones.

GEOLOGIC APPLICATIONS

There is a striking similarity between these systems of folds and the folds of the great mountain systems of the world, as is evident by comparing Figure 1 with tectonic maps of the Himalayas, Andes, Appalachians, and Alps. Anticlines, synclines, domes, cuvettes, overthrust sheets, amygdaloidal folds, echelon folds, parallel folds, virgations, and many other tectonic features are common to the screen and to the terrestrial crust.

Just as the earth is regarded by some geologists as consisting of three concentric layers—an interior and exterior solid and an intermediate liquid—so the screen consists of an interior solid layer, the muslin; a viscous substratum; and the nearly solid, exterior dull-black layer.

The mandibu[illegible]eory of Suess exacts an improbable rigidity and competence in [illegible]stal blocks of sial. The compressive forces of a "foreland" can operate over only short distances. It is improbable that they can cause uniformly folded zones with a breadth of hundreds, and even thousands, of kilometers when the thickness of the crust is thought to be only a few kilometers.

According to the phenomena of the screen, a theory of different rotational velocities of the telluric spheres appears more probable. Dragging, due to the irregularities of the surfaces of contact between them, disturbs the equilibrium of the solid spheres, resulting in folds and faults in the external or crustal one.[2] The plutonic earthquakes,[3] with foci at depths of hundreds of kilometers, appear to indicate a drag against the surface of the nuclear solid sphere that may correspond to that between the viscous liquid and the muslin base of the screen. Experimental geology may thus throw light on the physics of the globe and clear up many obscure points in the internal structure of the crust.

While making these observations, I received the excellent work of Professor H. S. Summers.[4] In describing recent experiments on materials with the properties of sial and sima he recounts the experiences of J. S. Mann with substances similar to those on the screen and the failure of his experiments. These experiments were more successful. Without resorting to expedients that impaired the similarity of the laboratory phenomena to the terrestrial, we reproduced almost perfectly the natural structures.

[2] Arthur Holmes, "Radioactivity and Earth Movements," *Trans. Geol. Soc. Glasgow*, Vol. XVII, Part III (1928–31), pp. 559–606.

[3] James B. Macelwane, "Plutonic Earthquakes," *Natl. Research Council Bull. 90*, "Physics of the Earth," Part VI (1933), *Seismology*, pp. 32–36; G. J. Brunner, "The Earthquake of September 6, 1933, and Its Bearing on the Problem of the Deep Earthquake," *Trans. Amer. Geophysical Union 15th Ann. Meeting* (1934), pp. 72–77.

[4] H. S. Summers, "Experimental Tectonic Geology," *Rept. 21st Meeting Australian and N.Z. Assoc. for the Advancement of Sci.* (1932), pp. 49–75.