SUMMARY

Object of the present investigation were the syngenetic structures of graded beds ("turbidites) of the Apennines, their interpretation in the light of the turbidity current hypothesis, and their orientation. A regional mapping of these orientations has disclosed a single persistent trend of current flow, from which conclusions can be drawn regarding the source of the clastics, the mechanism and environment of sedimentation, and even the subsequent tectonics.

Ch. I. Three major Tertiary turbidite formations: macigno, marnoso-arenacea, and Picene flysch, have been surveyed in detail. These formations represent similar, successive stages of orogenic development, and their sedimentary phenomena are very much the same.

Ch. II. Stratification is extremely regular. The turbidite beds are commonly graded; but, as the grain size rarely exceeds that of medium sand, grading in thick beds is not very marked except near the top.

These top levels, and separate fine-grained beds, are generally laminated and may reveal characteristic structures: ripples (transversal, periclinal, or longitudinal), current-lamination, convolution. Some lamination planes are variously striated. Coarse, elongate grains tend to be aligned.

Ch. III. Among sole markings flute casts are the most common. On a few bedding planes, minute terraces record the lamination of the eroded underlying mud. Frondescent casts are a novel type of erosional marking.

Groove casts intersect, on many soles, at angles up to 30°; the directions usually constitute two distinct systems of which one is parallel to the principal orientation. The oblique systems are probably due to offshoots advancing in fron of the main current. The majority of grooves is supposed to have been made by benthonic animals, dislodged and swept along passively at high speed by the turbidity current.

Slide marks and filled erosion channels occur.

Ch. IV. Many load casts evidently developed from erosional markings. Some other soles are wrinkled in variegated and more or less random patterns. A few recurrent and distinctive forms (striations, squamiform and syndromous load casts) have been recognized.

Slump structures are rare; they constitute zones of differential slip parallel to the bedding. To judge from the orientation of these slump foldings, many are due to posterior tectonics rather than to the primary depositional slope. One instance of injected sand dykes has been found.

Ch. V. Fossils are very scarce. Reworked plant fragments occur in turbidites, but not in the intervening pelites. The situation of echinid remains suggests burial in situ by turbidite sedimentation. Antecedent tracks and burrows in the mud floor are preserved as casts on turbidite soles. Post-depositional, sand-

filled burrows through and below thick turbidite beds pose an ecological problem.

Ch. VI. A single constant current direction can be inferred from the orientation of the various syngenetic structures of one turbidite bed. In each outcrop the current directions of nearly all the visible beds correspond closely to a single trend; these trends have been mapped.

Ch. VII. For the measurement of sedimentary directions, the pretectonic situation of the strata must be reconstructed; this is done most easily by the use of a specially designed compass. With steep dips, axial pitch must be allowed for; and measurements on overturned beds are invalid unless the tectonic axis has been carefully ascertained.

Ch. VIII. The observed current trends are recorded on the accompanying map: their uniformity and parallelism are remarkable. Deposition of the turbidites was apparently from currents that flowed lengthwise from the northwestern extremity of the Apennine range, parallel to the tectonic strike.

It is also revealed that large rootless slabs of macigno and marnoso-arenacea have been variously rotated from their pretectonic orientation, without disintegrating. This constitutes an independent new proof of allochthony, as well as of emplacement by individual sliding as opposed to nappe tectonics.

Turbidity currents must have flowed down the general slope of the basin; deflexion by the Coriolis effect was very slight. The uniform, longitudinal current trend thus necessitates two hypotheses: an axial slope of the successive foredeeps where turbidites were deposited, and a source of clastics to the northwest.

The first hypothesis is in harmony with what is known of the tectonic development of the northern Apennines; moreover, deposition itself would tend to build a gradual slope away from the source area. Such long slopes imply deposition at bathyal depth, which is confirmed by the available paleontological evidence and by the complete absence of shallow-water features.

Location of the source area of sand at the northwestern extremity of the chain gets rid of a long-standing difficulty: how to account for the sudden copious supply of sand to an Oligocene trough, flanked by tectonic ridges that consisted of marls and limestones only. In the area where turbidity currents now appear to have originated (Liguria and adjacent regions), on the contrary, arenaceous sediments prevailed.

Ch. IX. Observations on a number of minor turbidite series of the Apennines serve to confirm and amplify some of these points. Calcareous turbidites exhibit, as far as observed, the same structural phenomena as sandstones.