

## GEOLOGY AND GROUND WATER OF ATOLLS

The geological problem of the origin of coral reefs and atolls has been one of recurrent interest and great durability, commencing with the famous subsidence theory of Darwin (1837). Both geologists and biologists in the century since Darwin's publication have accumulated facts according to their opportunities and contributed to the discussion. Several divergent theories have been developed including Semper's lagoon-solution theory, Daly's glacial-control theory, and the antecedent-platform theory invoked by Ladd and Hoffmeister, with the greater number of workers supporting either the subsidence or the glacial-control theory. In recent years it has become apparent that for the various observed conditions no single answer may be sufficient, and that the merits of the leading hypotheses vary according to the age of the atoll and its location.

Of necessity the earlier work was largely limited to individual deductions based on the sea-level plans of atolls, very incomplete knowledge of their submarine slopes, and deductions only as to their structure. Increase in the number and accuracy of soundings, both around atolls and over the seamounts that appear to be closely related, has come through improvement in sounding techniques, particularly with the development of the sonic method. There has been increasing emphasis on the ecology of the reef-forming organisms and the environmental aspects of the various processes of erosion and sedimentation. Drilling on Funa-futi, later on the Great Barrier Reef and Kita-Daito-Zima, and last on Bikini has contributed data on the local structure but has not resolved the problem. Various geophysical techniques have been the most recent to be applied, as particularly at Bikini.

Until recently comparatively little attention has been given to the details of structure in the sections of the atolls above and at small depth below sea level in their relation to the ecology of the subaerial organisms including man.

Three chief lines of study need to be continued:

1. Deep drilling and other crustal sounding investigation by geophysical techniques and bottom coring, under both atolls and seamounts;
2. Geological mapping, both subaerial and submarine, combined with analysis and evaluation of processes;
3. Ecological studies on the islands, on the reefs, and in the lagoons and oceans.

The results of all three must be combined with contemporary tectonic and paleogeographic knowledge to promote understanding of coral reef origins.

Present knowledge of the ground-water hydrology of coral atolls is limited to a few scattered spot observations and a detailed but short-period series of measurements on one island. Apparently with sufficient rainfall, the larger islands of an atoll are capable of maintaining lenses of fresh ground water,

generally of the Ghyben-Herzberg type, though subsurface structure may in some cases introduce complexities in their functioning. Recent studies indicate an important control of vegetation and human ecology by ground-water composition.

Research considered desirable in the ground-water hydrology of atolls may be outlined as follows:

1. Shallow subsurface exploration to determine in detail the rock types and structure and the shape and nature of the fresh-water lens on enough islands to indicate the expectable range of conditions;

2. Long-term observations on islands with a variety of climates to determine the reaction of the lenses in size, shape, and salinity to tidal and other sea-surface fluctuations and to short-term and seasonal changes in rainfall;

3. Long-term measurement of rainfall on enough islands to indicate the distribution of rainfall over the ocean, and compilation of available rainfall data;

4. Pumping tests to determine the safe yield of fresh ground water from atoll islands;

5. Checking and extension of the studies on the ecological controls made by ground water.

Doak C. Cox

Dan A. Davis

Chester K. Wentworth