

but it is the author's opinion that if anything is to be revealed from the shape of the glacial rock surface concerning ice dynamics at the bottom of glaciers and ice sheets—and knowledge on this subject is still incomplete—discussions must proceed on the basis of accurately expressed observations.

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#### REFERENCE

1. Svensson, H. Morphometrischer Beitrag zur Charakterisierung von Glazialtälern. *Zeitschrift für Gletscherkunde und Glazialgeologie*, Bd. 4, Ht. 1-2, 1958, p. 99-104.

### EARLY DISCOVERERS

#### X I

### BERNARD PALISSY ON FROST SHATTERING AND RIVER ICE

PALISSY lived in France from about 1509 to about 1590. His two books<sup>1, 2</sup> are of particular interest to geographers and geologists.<sup>3</sup>

Palissy argues that God did not create the earth to be idle and though he supplied *all* materials on earth at the time of the Creation, the *form* of these materials is constantly changing. The "growth" of rocks from salt-charged "congelative water" is therefore exactly balanced by frost shattering and other processes. Frost shattering, like the "growth" of very hard rocks, occurs mainly in cold districts, such as the Ardennes, the Black Forest, the Pyrenees and the Auvergne; but the marl of the Paris Basin is also "dissolved" by frost. The incidence of frost is directly related to orientation and site.

When held up to the light, water, ice and quartz all reveal internal sparkles and are alike in weight, colour and coldness. They are therefore all made of the same materials—salt and water. Ice is merely water that has congealed or petrified because it contains a particular type of salt.

According to Palissy, a popular contemporary belief was that rivers froze from the bottom upwards. Palissy objects that river ice does not bear the impress of the river bed, does not contain mud and pebbles in its lower layers, and is free from the bodies of hibernating fish killed by pressure when the water froze. Moreover, it is from the air and not from the earth that the cold for freezing comes, and so the bottom water cannot freeze until all the upper water has frozen and current flow has ceased. In fact the bottom water is *warmed* by the earth's heat and by little springs.

Ice first forms at the sides of a river, on the surface. As more ice forms the river level falls and the original ice, its sides and surface laden with detritus from the banks, sinks to the bottom. There, melting occurs, releasing the detritus, so that the ice rises buoyantly once more and drifts downstream until blocked by some obstruction. When a number of floes are so halted the water upstream can freeze across its full width.

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1. Palissy, B. *Recepte véritable par laquelle tous les hommes de la France pourront apprendre à multiplier et augmenter leurs thresors*. La Rochelle, Barthelemy Berton, 1563. 130 p.
2. ——— *Discours admirables, de la nature des eaux et fontaines, tant naturelles qu'artificielles, des metaux, des sels et salines, des pierres, des terres, du feu et des emaux*. Paris, Martin le Jeune, 1580. 361 p.
3. Thompson, H. R. The geographical and geological observations of Bernard Palissy the Potter. *Annals of Science*, Vol. 10, No. 2, 1954, p. 149-65.