Geoscience Canada

Tidal Power

Christopher Garrett

Volume 1, Number 1, March 1974

URI: https://id.erudit.org/iderudit/geocan1_1br02

See table of contents

Publisher(s)

The Geological Association of Canada

ISSN

0315-0941 (print)
1911-4850 (digital)

Explore this journal

Cite this article

Garrett, C. (1974). Tidal Power. *Geoscience Canada*, *1*(1), 55–56.

Tidal Power

edited by T. J. Grey and O. K. Gashus. *Plenum Press, 630 p., 1972. $28.00.*

Reviewed by Christopher Garrett, *Department of Oceanography, Dalhousie University, Halifax, N.S.*

"Qu'est-ce que l'Océan—Une énorme force perdue"

Victor Hugo.

With this quotation G. Mauboussin concludes his article, in this symposium proceedings, describing the French tidal power project at La Rance. But just how "énorme" and "perdue" is the ocean's power? Victor Hugo may have anticipated plans, of varying potential, to harness temperature gradients, ocean currents or wave energy, but if he was thinking of tides he probably did not realize how equally enormous man's energy consumption would become. Current U.S. consumption of electricity alone is at an average rate of some 200 gigawatts (1 gigawatt = 10^9 watts), while the world-wide dissipation rate of lunar tides (known from the secular acceleration of the moon) is about 5,000 gigawatts (Rochester, 1973); with a further contribution of perhaps 25 per cent from solar tides. Extracting tidal energy at a rate faster than a very small fraction of this apparently wasted tidal dissipation would not only be exceedingly difficult, but would probably substantially affect the tides themselves. Hubbert (1971) cites a total potential tidal power of 64 gigawatts. Tidal power is clearly not a solution to man's energy crisis.

However, in places where tidal energy is apparently available in large quantities it has attracted attention as a source of clean, renewable power. The Bay of Fundy in Eastern Canada is a promising site, and in 1971 an international conference on tidal power was held in the nearby city of Halifax. The volume under review, first published in February 1972, constitutes the proceedings.

The keynote lecture which takes up the first 100 pages of this 700 page volume, is a review by F. L. Lawton of plans to harness the tides of the Bay of Fundy, with emphasis on the extensive study completed in 1969. The three sites considered in most detail have a total potential of some five gigawatts (depending greatly on the type of power plant). The second article, by the same author, entitled "Economics of Tidal Power", leaves one with admiration for the economist in his apparent ability to evaluate the cost of such an unprecedented scheme to four significant figures. Tidal power is highly capital-intensive (requiring about one gigadollar for the Fundy schemes), and high interest rates make the resulting power rather expensive. A complication in evaluating the economics is that a tidal power plant should have a long lifetime (75 years was assumed) compared with thermal and nuclear plants (about 30 and 25 years respectively).

The two currently operating tidal power schemes are described. Mauboussin's article on the French plant at La Rance, with an installed capacity of 240 megawatts, conveys a sense of adventure, but apparently the French government was not sufficiently impressed to proceed with the very much larger Chauze project originally planned. Bernshtein describes the experimental Russian project, of less than one megawatt, at Kislaya Guba, and writes enthusiastically of the potential of tidal power. But there is no mention of any Soviet plans to undertake a larger development in the near future.

There are also articles describing the tidal power potential of Cook Inlet in Alaska and San José Gulf in Argentina, and a number of papers discuss problems of barrage construction, turbines, concrete, corrosion and other topics of importance to tidal power development.

Of more interest to the geoscientist is the paper by Pelletier and McMullen describing the unusual sedimentation patterns in the Bay of Fundy and Minas Basin. Predictions for redistribution of sediment after construction of a tidal power plant are most uncertain. The 1969 report on Fundy Tidal Power estimated 150 years as the period over which the basin behind a tidal power dam in Minas Basin would silt up significantly, but again without much conviction, and it was stated that studies with hydraulic models would be required before a final design could be undertaken.

An important article by Owen and Odd attempts to overcome this reliance on hydraulic models for studies of sediment transport. The authors develop a one-dimensional, two-layer, mathematical model of the Thames estuary, and, using a computer, investigate the movement of mud banks that would follow the installation of a barrage in the Thames (to protect London from flooding by storm surges). The parametrisation of sediment suspension, transport and deposition may be too crude as yet, but the model seems to be a significant innovation.

Use of numerical rather than hydraulic models for studies of the tides themselves is now routine. Parkinson describes the numerical model of tides in the Bay of Fundy which was developed to predict changes in the tidal regime that would result from installation and operation of a tidal power plant at various sites near the head of the Bay. No equations are given but the published results fit the existing tidal regime well (remarkably so in view of the totally unphysical assumption of a tidal amplitude 16 per cent greater in the centre of the entrance to the Bay than at the edges). Assuming that the tides at the entrance to the Bay are unchanged by a tidal power scheme the model was rerun and predicted a reduction of some five to ten per cent in the tidal amplitude near the barrier. The basic assumption has since been disputed (Garrett, 1972); it seems that the Bay of Fundy cannot be treated independently of the Gulf of Maine. Also, assuming a fixed amplitude at the entrance to the system is the wrong physics and can lead to totally incorrect predictions in a near resonant system such as this. A current view is that tidal ranges would decrease much less than previously predicted at the head of the Bay, and actually increase slightly over the Gulf of Maine. The problem is not yet fully resolved, but is clearly of environmental as well as economic importance. One wonders what other major surprises might be in store for us if we ever build a large tidal power plant.

A short article by Waller discusses environmental effects of tidal power. It seems that fisheries, which are of comparatively small economic importance anyway, would be largely unaffected. A potentially more important effect is alleged to be the increase in number of shipworms that could result from reduced water exchange. Migrating shorebirds, which feed extensively on mud flats at the head of the Bay of Fundy, are ignored.

Nothing is said of other possible tidal power sites in Canada, though Godin (1973) describes the potential, several gigawatts, of the large tides in Ungava Bay, and suggests that tidal power schemes in this area could be combined with hydroelectric power to produce a continuous output.

The volme is nicely produced. The typeface employed is unattractive, but the many illustrations and photographs, though printed on the same paper as the text, come through well. A rudimentary index has been compiled, but it is a pity that the editors did not take advantage of this as a symposium proceedings, rather than a collection of submitted articles, by including some record of the discussion that must have followed each lecture.

The oceanographer and geoscientist, perhaps aware of the somewhat limited potential of the tides, are apt to ignore tidal power. But the Bay of Fundy in particular does hold promise as a substitute for increasingly expensive thermal power and as a supplement to nuclear power. Its development cannot be left entirely to the engineer and politician.

References

Garrett, C., 1972, Tidal resonance in the Bay of Fundy and Gulf of Maine: Nature v. 238, p. 441-443.

Godin, G., 1973, The tidal power potential of Ungava Bay and its possible exploitation in conjunction with the local hydroelectric resources: Ottawa, Dept. of the Environment, Marine Sci. Directorate, MS Rept. Ser. no. 30.

Hubbert, M.K., 1971, The energy resources of the earth: Sci. Am. v. 224, no. 3, p. 60-70.

Rochester, M.G., 1973, The earth's rotation: Trans., Am. Geoph. Union, EOS, v. 54, p. 769-781.

MS received, December 17, 1973.

Huronian Stratigraphy and Sedimentation

edited by Grant M. Young.
Geological Association of Canada, Special Paper 12, 271 p., 1973.
$12.00 to members, $14.00 to non-members.

Reviewed by F. J. Pettijohn,
Department of Earth and Planetary Sciences,
Johns Hopkins University,
Baltimore, Maryland 21218.

Most of the papers in this volume were presented at a symposium held at Sudbury, Ontario, in 1971, during the 24th Annual Meeting of the Geological Association of Canada. Some of the papers deal with rocks not strictly Huronian as that term is presently defined. In all, twelve papers are included: Nipissing diabase of the Southern Province, Ontario by K. D. Card and E. F. Pattison; The Huronian Supergroup, a Paleoaphebian succession showing evidence of atmospheric evolution, by S. M. Roscoe; Stratigraphy, petrography and paleocurrent analysis of the Aphebian clastic formations of the Mistassini-Otish basin, by E. H. Chown and J. L. Caty; Stratigraphy and depositional environments of Upper Huronian rocks of the Rawhide Lake-Flack Lake area, Ontario, by John Wood; Tillites and aluminous quartzites as possible time markers for Middle Precambrian (Aphebian) rocks of North America, by G. M. Young; the Proterozoic sedimentary rocks north and northeast of Sudbury, Ontario, by H. D. Meyn; Lower Huronian stratigraphy in Hyman and Drury Townships, Sudbury District, by F. Q. Barnes and F. J. Lalonde; Paleogeography of the Mississagi Formation and Lower Huronian cyclicity, by P. A. Palonen; A review of recently acquired geological data, Blind River-Elliot Lake area, by J. A. Robertson; Clastic dykes at Whitefish Falls, Ontario, and the base of the Huronian Gowganda Formation, by F. W. Chandler; Stratigraphic framework of Middle Precambrian rocks in Minnesota, by G. B. Morey; and The Penokean Orogeny in