GEORGES PANNIER
1325 SOUTH CARONDELET
LOS ANGELES, CALIFORNIA 90057
U.S.A.

R. de entrada 739
Rec. 27-4-1967
Resp.

April 26, 1967

Mr Raul de Smandek
Consul of Brazil
Brazilian Consulate
Los Angeles, Calif 90028

Dear Sir:

Your letter of April 5th - ref. No 190 - has been duly received. Thank you very much for the action taken over my proposal.

I believe worthwhile to bring to your attention some other developments of mine which should be of particular interest in a developing economy, like the Brazilain economy.

For your information, several references to or publications related to my research works have been published, are currently published or are slated for publication.

As one example, the attached copy of page 670, Engineering & Mining Journal, Centennial issue, June 1966, will give you a glimpse of such works. Moreover, I wrote a rather extensive review on the same subject that began in the current issue, April 1967, of California Mining Journal and will continue on three more issues. Other related references are available.

The importance of such developments for a better backing of the currencies has no need to be emphasized. Yet, you guess it, there is much more than it can be published on the subject and I feel that some of my works along such lines could be of tremendous advantage with regard to Brazilian resources and needs.

It is not all. Another leading technical magazine has retained and slated for publication in June and article of mine which will introduce a new concept in mineral treatment as well as the development of the related equipment. Promising applications have been seen in the fields of ore dressing, coal or oil shale treatment, mineral beneficiation, etc. Indeed, a new dimension to economic mineral beneficiation.

Still another project of mine, " the continuous making of iron semi-finished products - (strips, sheets, pipes) - directly from fine iron ores " has been evaluated last year by the staff of a leading research Institute in the U. S. While the Institute found itself barred from proceeding further, because of conflict of interest, it reported a most favorable opinion of my concept and works.

That such methods would make the best of Brazilian high grade iron ore is beyond question.

Among other experiences and references, may I say that I have also devised and led laboratory development of new methods

.....2

Mr Raul de Smandek, Consul of Brazil
Brazilian Consulate, Los Angeles

April 26, 1967

and equipments for well-known concerns; i. e., titanium metallurgy, ceramic-to-metal bonding, etc, etc. I have a working knowledge of uranium extraction from low-grade ores. Nevertheless, all of the above is only part of the story.

It is my guess that I might best use such experience and competences in a developing country, like yours, Brazil, where I could help developing new resources and means for a growing industry. Thus, I would be prepared to consider joining Brazilian interests so as to make the best of these techniques that I have developed or may conceive to fit specific requirements.

Therefore, on the basis of the present letter, I would greatly appreciate to know of your opinion on the advisability to proceed further, and I shall welcome your comments, your suggestions, your questions. Should you find it advisable, I would be ready and glad to meet you at your office and to present you some testimonials and references pertaining to the above matters.

As I already stated in my previous letter, I am a French national, a professional metallurgist with extensive experience abroad and with some fourteen years of experience in the United States in metallurgical research and as a consultant with well-known concerns.

I shall be glad to hearing from you.

Sincerely yours,

G. Pannier
Consultant

Encl: Copy of page 670, June 1966 issue, Eng. & Min. Journal.

Mining the Sea

BEFORE THE DEEP SEA MINING PROGRAM discussed in the previous section reaches its full peak, it is possible that some mineral processing engineers of the future will bypass deep sea mining entirely and go after the source of the ocean-bottom precipitates — the sea itself. The accompanying table shows that estimates of metals and other elements dissolved in the sea are fantastically large.[5]

Extraction of minerals from sea water is, of course, not new. In the U.S. alone the value of materials extracted from sea water totaled more than $100-million in 1964, according to Battelle Memorial estimates. The value of materials extracted included: NaCl, $11-million; magnesium, $47-million; magnesia $20-million; and bromine, $23-million.

Office of Science & Technology estimates that by 1980, nuclear distillation plants will be feasible which will be able to produce 2.3-billion gal of fresh water per day, and that possibly six or more of these plants would be needed to supplement southwest and Gulf Coast water supplies. It has been estimated by others that one of these plants alone could produce as a by-product of desalting: 3½ times the salt, 30 times the magnesium, 3 times the bromine, and nearly twice the potash and 80% of the sulphur requirements of the U.S.[5] With possibilities such as these, it is almost inevitable that commercial ventures will soon consider nuclear-powered desalination plants producing power, fresh water and minerals in one gigantic undertaking. Success of such a venture would also mean self-sufficiency in many ways for any nation which borders the sea.

The concept of extracting gold and other metals from the sea has been under study for many years. Oliver North, *E/MJ* patent correspondent, has reviewed some 30 patents issued in the U.S., Germany, England, and Australia, on extraction of minerals from the sea. Oldest patents date back to 1896.

Georges Pannier, research metallurgist and consultant, has also made a thorough search of the subject and abstracted the accompanying table showing gold content in sea water in various places. Admittedly, methods of analysis may be subject to question, but the fact remains that there is no such thing as an average metal content in the sea. This is the important clue to a sea-water minerals extraction process. Most assuredly, waters draining gold-bearing rivers fed from gold-bearing lands, enrich sea water gold content in logical areas as the table indicates.

Patents issued to date and correspondence with researchers studying metal recovery from sea and river water, suggest a research program along these lines:

1) Development of an inexpensive, rapid and accurate method to determine the micro-quantities of metals in sea water. USGS and other agencies have developed rapid methods to determine metal content of samples in parts per million or even parts per billion for some metals.

2) A survey of ocean current and river waters to determine the richest gold-bearing (or metal-bearing) waters for processing plants.

3) Development of a process to capture metal ions. Here, too, modern research in ion properties and migration should speed results. New reagents such as chelates, ion exchange resins, etc., also merit attention.

4) Patents indicate that cost of power to pump water through a recovery plant or unit would be excessive. Accordingly, it is suggested that recovery units be placed in moving ocean currents or streams, or that porous containers of metal-capture reagents or materials be towed through the sea. Other patents suggest the use of tidal currents to bathe large vats of materials which will capture gold ions.

5) Any method developed will require the movement of tremendous quantities of water for processing. For instance, 10,000 micrograms is 0.01 gram. This is equal to 0.0003215 oz per ton of sea water. Obviously, a hard-rock gold miner would turn up his nose at this target, but in a new era when the scientist can command the migration of ions and capture them, the goal of sea-water gold extraction is within the realm of technical feasibility.

In 1958, H.K. Porter started the first commercial operation for the production of periclase (MgO) by a "double burning" process to produce high-purity basic refractories at non-premium prices. The MgO is extracted from sea water by a calcium-hydroxide precipitation process at the company's Pascagoula, Miss., plant on the Gulf of Mexico.

[4] "The impact of new technology on mariner and mineral," by John A. Wuth, director of exploration, Ideal Cement Co. Part of a symposium on minerals by International Minerals & Chemical Corp., February 1967.

[5] "The ocean: Mining's newest frontier," by H. D. Hess, U.S. Bureau of Mines, Tiburon, Calif., *E/MJ*, August 1965.

These Reserves Are Dissolved in Sea Water

	Weight percent x 10^4	Tons of element per cu mi of sea water	Total tonnage of element in oceans
Chlorine	18,930	89.4×10^6	29.3×10^{15}
Sodium	10,561	49.7×10^6	16.3×10^{15}
Magnesium	1,272	6.0×10^6	2.0×10^{15}
Calcium	400	1.9×10^6	0.6×10^{15}
Potassium	380	1.8×10^6	0.6×10^{15}
Bromine	65	306,000	0.1×10^{15}
Strontium	13	61,200	$20,100 \times 10^9$
Silicon	4.0	21,200	$6,950 \times 10^9$
Aluminum	0.5	2,360	770×10^9
Lithium	0.1	470	154×10^9
Phosphorus	0.1	470	154×10^9
Barium	0.05	235	77×10^9
Iron	0.02	94	31×10^9
Manganese	0.01	47	15×10^9
Copper	0.01	47	15×10^9
Zinc	0.005	24	$3,650 \times 10^6$
Lead	0.004	19	$6,230 \times 10^6$
Molybdenum	0.0005	2.4	790×10^6
Silver	0.0003	1.4	470×10^6
Vanadium	0.0003	1.4	470×10^6
Nickel	0.0001	0.47	154×10^6

Source: Abstracted from Sverdrup, H., M. Johnson, and R. Fleming, The Oceans, Prentice-Hall, Inc., New York, N.Y., 1942, pp. 175-177; adapted from Mero, John L. Mining the Oceans, Underwater Yearbook, Chicago, Ill., 1962, pp 6-11.

Gold Content of Sea Waters

Analytical method	Water origin	Micrograms per ton
Spectrographic	Senegal Coast	—
Chelation	Bay of Naples	14
Ion exchange	Cape Town	9
Co-precipitation	Puget Sound	100-200
Precipitation	Numerous	4 (average)
Radioactivity	England-France	14-400
Co-precipitation	Sydney	3,500-65,000
Co-precipitation	Christiana	5,000-6,000
Co-precipitation	—	8
Evaporation	—	4,000
Electr. couple	Washington	0-46,000
Co-precipitation	—	up to 65,000
—	Iberian Coast	up to 2,000
Evap. Sorbtion	Japan	13,000
—	Bay of San Francisco	11,000
—	Bay of San Francisco	16,000
Co-precipitation	Japanese Coast	up to 20,000

Source: Research of patents and literature recorded in seven countries for the period 1872-1964, by Georges Pannier, research metallurgist and consultant.