

RED MUD

THE NOT-SO-SHINY SIDE OF ALUMINUM

By DR ARUN S. WAGH AND GERALD TOOMEY

Under an azure sky, a car heads out of the Jamaican capital of Kingston and winds its way along a narrow hilly highway past green sugarcane fields, banana orchards and ruminating goats. Along the roadside, old women cook "jerk" pork and chicken over fire pits. Young men and children, shaded from the hot Caribbean sun by their fruit stands, wait patiently for passing motorists to buy their strings of tangerines. The landscape brings home the fact that agriculture is the number one sector of the economy. But bauxite and alumina are the most important exports.

After two hours on the road, the car drives through a guarded gate and comes to a halt at the main office and laboratory of Alcan Jamaica's Kirkvine Works in the parish of Manchester. It is one of the four alumina plants on the island. The four occupants of the car have come to tour the operation and meet with the technical staff.

With the financial support of IDRC, a team of Jamaican and Canadian scientists, is studying "red mud", the inevitable waste produced by such alumina plants. Their objective is to reconcile Jamaica's need for foreign exchange with its need to preserve its exceptional environment for tourists and its soil for farmers.

Jamaica's bauxite lies little more than a metre beneath the feet of the island's people. This often rust-coloured earthy raw material contains the important mineral compound Al_2O_3 — aluminum oxide or simply alumina. After export, this is processed into aluminum from which familiar products, ranging from auto parts and roofing material, to foil wrap and cooking pots, are made. Its wide-scale use in the aerospace industry, in fact, makes it a strategic metal.

Bauxite mining and alumina processing generate 75 percent of the export earnings of the country and employ 4800 people. Although seriously hit by the recent recession, the two industries remain key elements in the Jamaican economy, along with agriculture and tourism.



Photos: Gerald Toomey, IDRC



Materials scientist Dr Arun Wagh examines a piece of dried mud.

HIGHLY CAUSTIC SLURRY

Unfortunately, discharge tailings due to alumina production, whether in Jamaica or elsewhere, can contaminate groundwater and adversely affect agriculture because of the land needed for storage of the toxic wastes. This less glossy side of the alumina

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industry is a consequence of the Bayer process by which alumina is dissolved out of bauxite with the addition of caustic soda. This yields a highly caustic red mud. In many alumina plants around the world, including four in Jamaica, enormous quantities of this slurry are pumped into old abandoned bauxite mines or natural valleys

with one end dammed up. Such artificially constructed ponds eventually fill up with the waste leading to an environmental problem exacerbated by the fact that Jamaica is an island measuring only 22 000 square km.

In world bauxite production, Jamaica ranks third after Australia and Guinea, with about 11 million tonnes mined every year. Some seven million tonnes of this is refined locally, producing 2.5 million tonnes of alumina and, at the same time, 12.5 million tonnes of liquid waste. According to a 1983 global report on the aluminum industry, published by the Brussels-based Groupe de recherche pour une stratégie économique alternative, Jamaica's estimated and proven bauxite reserves stood at almost 10 percent of the world's total of 32 billion tonnes at the end of the 1970s. If these riches are to be exploited for the country's benefit, the waste disposal problem must be solved.

BEAUTY IS SKIN DEEP

Typically a red mud pond in Jamaica is a massive land depression filled with the waste. It has a slope from the dyke end to the far end. The effluent is discharged near the dyke and flows into the pond, with heavier solids settling at the shallow end and more liquid mass flowing to the deeper side. This results in a drier side of the pond, a "soft-soil" region making up most of the pond, and a liquid side. The rain water also accumulates at the liquid side and makes it look like a lake with a blue reflection of clear sky. A boat or a raft can easily navigate on it.

The dry side has its own appearance too. As the mud dries, due to massive shrinkage, the surface cracks and looks like a drought-stricken area. Some of the smaller abandoned ponds in fact crack into very symmetric concentric circles with the centre at the middle of the pond. At first sight one does not realize that this beauty is probably only skin deep. The Jamaican mud is superfine and is self-sealing. The dry

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mud on the surface can trap viscous liquid underneath. One wonders what will happen if the trapped mud under the hydrostatic pressure of the overburden ever finds a way out! Only intensive research on the pond can answer this.

The soft-soil region is deceptive too. The surface may look smooth and uniformly red, but a throw of a stone immediately suggests that anything can sink into it and vanish. A boat cannot be used there because shear forces are too large. The caustic sludge is too dangerous for any such adventure. But since this covers the largest area of the pond, scientists must study the samples in this region to determine the dynamics of the mud. This demands ingenuity from the researchers.

Since the early 1950s, when the alumina and bauxite industries were first established, the caustic red mud has been directly pumped into such sludge ponds. Twenty years later, high levels of sodium concentration in some nearby water sources and wells were observed by the Ministry of Mines and Natural Resources. Increasing sodium levels and frequent accidental spills led the Ministry to monitor the quality of water in these areas and to establish criteria for water safety.

The main problem with the existing ponds is that little is known of their internal chemical and physical dynamics. While the constituent parts of Jamaican red mud are known — mainly iron oxide and residual alumina — many questions remain. How does the slurry settle? How much soda seeps into the aquifers and ground waters? After the dumping stops, what conditions are necessary for the contents to dry? What holds the particles of dry mud together? Is there a risk that the dried material will eventually crumble, turning the disposal sites into dust bowls?

These considerations motivated the University of the West Indies (UWI) in Jamaica and McGill University in Montreal, Canada, to ask IDRC's support for a cooperative research endeavour. Scientists of the Materials Laboratory in the Physics Department at UWI, and Professor Raymond Yong, Director of McGill's Geotechnical Research Centre (GRC), who has experience in the treatment of tar sand tailings in Western Canada, formulated a three-year research program. Its aims are to characterize Jamaican red mud, develop a predictive model of the ponds, and study the potential of Jamaican root starches as flocculants (thickeners). This eventually

Photo: Gerald Toomey, IDRC



evolved into a team effort supported by the local alumina industry (Alcan, Alcoa and Alpart), the Jamaica Bauxite Institute, the Scientific Research Council of Jamaica, and various departments of UWI.

"LET THEM LIVE IN MUD"

Environmental control is only one aspect of the red mud problem. A Jamaican industrialist and a former government minister, R.C. Lightbourne, considered Jamaican red mud a resource and, working with H.B. Baetz, developed and patented a process to extract iron out of the mud. Similarly, the US Bureau of Mines instituted a study on the possibilities of using red mud produced in the United States as lightweight building material.

Lightbourne's vision and the US Bureau's hopes failed, not because their logic and methods were unscientific, but because of the problem of drying the mud. It was uneconomical to produce solid waste. If one could simply remove the water from the mud, it could partially solve the environmental problem and the waste could be useful too.

In this respect a de-watering technique, based on the Guilini process used in Germany and further developed by Alcan scientists, is quite encouraging. In this process, the mud is thickened to almost 50 percent solids by flocculation and then the tropical sunshine is used to dry it further. The result is dry mud which requires much less land for disposal, does not flow and hence does not have the potential to contaminate the local water systems. This could provide the raw material for lightweight building products or for iron extraction.

NEW OPTIMISM

The establishment of some of the basic characteristics of Jamaican red mud under the IDRC-sponsored project and the introduction of the new disposal method have created a new atmosphere of optimism. While there is still concern about the existing ponds, projects are being initiated at UWI to look into the properties of the dry mud.

In an article titled "Let them live in mud", by Anil Agarwal (*New Scientist*, 16 December 1982), it is argued that all developing countries have one resource in common, and that is mud. In the case of red mud, the current research project is unique. It attempts to solve the waste problem of the major industrial activity of Jamaica, preserve the environment, and generate resources out of the waste. Expecting prosperity out of it may be a romantic dream, but certainly such research will develop indigenous technology hitherto unknown to the industrialized world. □

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