8 July 2005

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RE: A very serious mining threat to the integrity of Nahanni National Park Reserve, Mackenzie Mountains, Northwest Territories, Canada.

Dear Mr. Rao:

The purpose of this letter is to alert members of the UNESCO World Heritage Committee to a very serious threat to the physical and environmental integrity of Nahanni National Park Reserve that is posed by proposed development of a silver/zinc/lead mine close to the existing park and within its watershed.

I write as an Emeritus Professor of Geography and Geology, specializing in geomorphology (the study of natural landforms) and hydrogeology (groundwater flow systems). My particular expertise is in karst (limestone and dolomite dissolutional) landforms, caves and aquifers. I have investigated karst across Canada and around the world, have published extensively on the subject and am considered a leading world authority. In 1971-4 my research students and I studied Nahanni National Park Reserve and some remarkable karstlands immediately north of it. My work included a complete survey and evaluation of the bedrock geology, the geomorphology, Quaternary deposits, surface and groundwater hydrology (1974 and 1985 - see appended reference list) that, I am informed, contributed significantly to the decision to designate this Park

on the first list of World Heritage Sites in 1978, and formally confirm this with the first ever designation ceremony in 1979.

The present boundaries of Nahanni National Park Reserve are a series of straight landlines that enclose a narrow strip of terrain along the middle and lower course of the South Nahanni River and its principal tributary, Flat River, in the Ragged and Canyon Ranges of the southern Mackenzie Mountains. The upper courses and headwaters of these rivers and all of their larger tributaries such as Prairie Creek (below) are outside of the area that is currently protected. The Canadian Parks and Wilderness Society, the Dehcho First Nations, and many Canadians are campaigning to extend the boundaries to encompass the entire physical watershed of the South Nahanni, and the Nahanni karstlands. Their numbers include such well-known persons as Justin Trudeau, son of the former Prime Minister of Canada who himself visited the site before the Reserve was created and then played a major role in establishing it. The federal government has committed to expanding the park, and Parks Canada has signed an agreement with the Dehcho First Nations to work towards expansion of the national park with the watershed and karstlands identified as the area of interest. Meanwhile, permits are being issued for the further development of the Prairie Creek Mine within this watershed area.

The hazards posed by the mining operations being proposed at Prairie Creek may be divided into two parts (1) hazards to the Park from the mine itself, and (2) hazards to karst lands and aquifers along the route of the mine access road that is north of the Park, but within the area of interest for park expansion. These will be summarized in turn.

The Prairie Creek Mine prospect and its hazards.

The mineral deposits of interest are located in bedrocks directly alongside and above the channel of Prairie Creek, a major North bank tributary of the South Nahanni. The geological setting is in the west flank of an anticline (upfold) in regularly bedded limestones and underlying dolomites. The folding has created a steep-sided, elongated ridge with a crest that rises to more than 1500 metres above the South Nahanni River, which crosses it via First Canyon, a magnificent antecedent river canyon that is the greatest in Canada (see e.g. Ford 1991). Prairie Creek takes surface drainage from much of the west flank and becomes deeply entrenched into its strata a short distance downstream of the mine exploration site, creating a tributary canyon that spills into the River via a visually striking gravel delta three km upstream of the First Canyon. This delta is of unusual ecological significance.

Mine site infrastructure was developed at Prairie Creek in the early 1980s as part of an attempt by the Texas-based Hunt Brothers to corner the world silver market. This included a winter access road, an airstrip, underground workings, buildings and a tailings pond which has its dam directly along the left bank of the Creek. In 1982 the price of silver collapsed, Cadillac Explorations went bankrupt and the mine project was abandoned. Currently, Canadian Zinc Corporation has acquired the mine leases and is attempting to bring the mine into operation.

The minerals of economic interest are zinc, silver, lead, and copper. From Geological Survey of Canada Open File publications I understand that the deposits, which are geologically ancient, are contained within a mixture of Vein Massive Sulphides (VMS) and Stratabound Massive

Sulphides as ZnS, PbS, etc. There is also much iron and exceptionally high concentrations of mercury, a very hazardous substance. The VMS deposits can be envisioned as precipitates from ascending hot fluids that are emplaced in vertical or near-vertical fractures created by the fluid pressures. The stratabound deposits were almost certainly emplaced in pre-existing dissolutional voids within the limestones and dolomites that the fluids spilled into from the fractures; this qualifies them as 'Mississippi Valley-type' (MVT) deposits, which are amongst the most common types of lead-zinc ores worldwide. This indicates that these rocks have been karstified in the past. I suspect that the karst caves served as preferential targets for the rising fluids in fact; this is a commonplace relationship (see e.g. Ford 1986, 1996). The most comprehensive published discussion of the nature and extent of such *paleokarst* globally (including MVT) is found in Bosak *et al.* 1989. I was the principal text editor, and contributed the chapter on these phenomena in Canada.

My field research team has firmly established that there are modern karst landforms, caves and groundwater aquifers displaying such standard features as sinking streams and large springs in the limestones and dolomites on the eastern side of the First Canyon anticline (see below). We lacked the logistic support needed to study the west side of the anticline in any detail but noted cave mouths, etc. when passing at a distance. This indicates that, in addition to the paleokarst, there will be one or more modern karst aquifers within and around the Prairie Creek ore deposits.

In my professional opinion, mining will create a variety of serious hazards to the surface and ground waters, the flora and fauna, around the mine and in the South Nahanni River and Park downstream of it. Chief amongst them will be formation of sulphuric acid (a strong acid) by oxidation of the sulphides in the presence of water. Consultants for Canadian Zinc have suggested that the local limestone and dolomite will effectively neutralise this acid, but they are not specialists in this matter and appear to be indulging in wishful thinking. <u>All</u> sulphide deposits within carbonate rocks generate acids under natural conditions (see e.g. Worthington and Ford, 1995). When radically impacted by mining, the rates of acid generation are increased. In the *vadose* or *unsaturated* zone (above the water table) and in the shallow *phreatic* or *saturated* zone (beneath it) groundwaters are O_2-rich and so readily oxidize the sulphides to H_2SO_4. The kinetics of H_2SO_4 transport in karstic groundwaters are now quite well understood (see e.g. Klimchouk et al. 2000, Chapter 4.1.4, 5.2.8). Its solvent capacity is reduced at Fourth Order (or higher) rates as saturation is approached. This means that the acid can travel long distances underground (and at the surface) before its corrosive capacity is exhausted. Development of the Prairie Creek mine must impact the regional waters very strongly, in my opinion. The locations and rates of impacts will be most difficult to predict because they will depend upon the vagaries of solutional void distribution and connectivity within, around and down gradient of the deposits being extracted (plus other variables), and they will change (usually for the worse) with passage of time. I am also concerned with the fate of water pumped from the mine (oxidizing rapidly), of mineral dust from the open workings, from mine ventilation shafts, on conveyor belts to the concentration plant, or released during the concentration processes, etc. These too will be sources of H_2SO_4 that may be transported rapidly off-site. The abundant mercury could pose a hazard at every step in ore extraction and concentration.

Canadian Zinc proposes to extract the ore chiefly by underground workings and to backfill these with waste rock and ore once they are finished. This will emplace artificial conduits of very

high porosity and sulphide content deep into the aquifer both above and below the watertable. I consider it to be a recipe for groundwater contamination in perpetuity. All groundwater flow from the abandoned mine will be into Prairie Creek downstream or into karst springs in First Canyon.

As noted, the tailings pond in which sulphide fines will be deposited is directly alongside the Creek. Its deposits will be anoxic, preserving the sulphide for rapid oxidation if/when the pond dam fails.

This is a region of ongoing tectonic activity as illustrated by two earthquakes that took place in October and December, 1985 (Horner et al, 1987). The December event was one of the strongest earthquakes to occur in Canada within the past 50 years (magnitude 6.9) and had its epicenter on the North Nahanni River approximately 80 km northeast of the mine site. The October event (magnitude 6.6) caused one of the largest Canadian bedrock landslides ever, with an estimated 5 to 7 million cubic metres of rock crashing 1.6 km down from the crest to the toe of the slide. This occurred in the same steeply dipping limestone and dolomite formations as there are at Prairie Creek. It is a dangerous place to build a tailings pond with a fragile dam.

Finally it may be noted that, although it is proposed to mine chiefly underground, ugly visual scarring of the surface here will be unavoidable.

The Prairie Creek access road and its hazard to the Nahanni North Karst.

In May 2005 the Supreme Court of the Northwest Territories determined that Canadian Zinc's application to re-construct the winter access road to the mine (abandoned since 1983) was exempt from environmental assessment. The company is now in the process of obtaining a permit for this re-opening. It also plans to apply for an all-season road, I believe. If the mine is developed, the road will be the main route for the transport in of all equipment, supplies and fuel, and of all mercury-rich sulphide concentrates out. The company also proposes to use the road to remove stocks of toxic chemicals, including 40 tonnes of cyanide, from the mine site. The road corridor extends 165 km from the nearest all season road, the Liard Highway, to the mine site. It passes through an area of limestone and dolomite karst landforms and aquifers on the east flank of the anticline along a route North of the Park. We studied this region intensively in 1973-4, terming it the 'Nahanni North Karst'. It extends ~45 km NE from the River at the east end of First Canyon and is 15-20 km in width.

The North Karst is the most accentuated and important example of arctic/subarctic karst that is known anywhere on the planet at the present time. I have been advocating its addition to the Park (and its protection as a World Heritage Site) for many years. No karst landscapes as pronounced as those of Nahanni exist in Scandinavia (including Spitsbergen), Alaska or in western arctic/subarctic Russia. I have visited the main sites in these countries. I have seen less of the permafrost karst lands in Siberia (only the southern portion) but French, Polish and Russian colleagues who have studied those further north have not reported any karst of the scale or quality of the Nahanni. Its landforms include extensive tracts of limestone pavement; hundreds of sinkholes in bedrock or covering glacial sediments; major compound sink depressions that are up to several hundred metres in length, and patterns of karst corridors that

intersect to create the most striking example of a karst dissolutional labyrinth that is known in the Northern Hemisphere. Some long and deep canyons are drained entirely underground via sinkholes in their floors. There are three small but fine examples of poljes - broad, solutional depressions with corrosion-planed floors that are seasonally inundated. There are many beautiful caves now drained and relict above the modern water table. There are also many sinking streams and small perennial lakes that drain underground. The North Karst was in a pristine natural condition until the 1980s winter road was put in; fortunately, the road was little used and is reverting to wild.

The routes that the individual karst streams take after they sink are largely unknown, but a colleague and I inferred some likely courses from our field studies. The Nahanni North Karst is a very extensive area but, remarkably, it appears to drain to just two principal springs. 'Bubbling Springs' (our unofficial name) drain the karst at its northern end, rising through the topmost part of the limestone strata there, and discharging into a tributary of the Ram River. The three fine poljes almost certainly drain to these springs. The southern end is drained at 'White Spray', a major cluster of springs in the South Nahanni River and just above it, that emerge on the north (left) bank in First Canyon three km or so upstream of the Canyon mouth. These springs discharge from the dolomites nearly 500 m below the stratigraphic base of the main karst limestones. In the world scheme of karst hydrogeology, this North-South division of groundwater flow to the top and nearly the base, respectively, of the rocks constituting a major karst aquifer is very unusual, a rare feature. The aquifer is mature, drained by extensive water-filled cave systems that terminate at the two groups of springs. With the technology of the 1970s we were not able to explore any parts of these active caves.

We do not know where the underground watershed between these two sets of springs lies, so we are not sure where all of the water that goes underground eventually drains. The implication is that any spills of fuel oil, hydrocarbons, cyanide, sulphides etc. along the course of the road through the karst belt will certainly impact the groundwater drainage to Bubbling Springs. That will be inescapable. What we do not know is whether road spills will drain into the existing Park Reserve through White Spray Springs as well.

Karst groundwater aquifers, being spacious places, are hosts to a large variety of phreatophyte and other troglodyte species of small animals such as isopods. To my knowledge there has never been any study or attempt to inventory the underground fauna of the Nahanni karst. Given that this karst is old and has long been isolated from other karst drainage systems, there is a very high likelihood that it will contain one or more entirely new species of aquatic animals. Their environment is extreme (cold, as well as being perpetually dark and with limited nutrition like most other karst aquifers). Therefore, the fauna will be very fragile, likely to be heavily impacted by any spill from a road.

Conclusions

My hope is that the information presented to the World Heritage Committee in this letter will persuade it to contact the federal government of Canada at the highest levels in order to express its grave concern that a permit to re-open the winter road to the Prairie Creek mine is being granted without appropriate environmental assessment, with the possibility that there will be an

all-season road and an operating mine in future. I believe that the development and operation of the proposed Prairie Creek Mine threatens the very values that make the Nahanni worthy of World Heritage designation. If the mine proceeds I shall urge the World Heritage Committee to place Nahanni National Park Reserve on the list of World Heritage In Danger, and, if the mine is developed, to strike Nahanni National Park Reserve from the World Heritage list.

Yours truly,

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Emeritus Professor of Geography and Geology, McMaster University.

Cc: Mr. David Sheppard, Head, IUCN Programme on Protected Areas

Right Honourable Paul Martin, Prime Minister of Canada

Grand Chief Herb Norwegian, Dehcho First Nations

Hon. Andy Scott, Minister of Indian and Northern Affairs Canada

Hon. Stéphane Dion, Minister of Environment, Canada

Mr. Alan Latourelle, CEO, Parks Canada Agency

Hon. Joe Handley, Premier, Northwest Territories

Todd Burlingame, Chair, Mackenzie Valley Land and Water Board

Canadian Parks and Wilderness Society

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