DISCUSSION / DISCUSSION

Discussion of “Analysis and reinterpretation of deformation features in the Rouge River valley, Scarborough, Ontario”[1]

N. Eyles and A. Mohajer

Introduction

Structurally deformed Pleistocene sediments along the Rouge River are located < 7 km from Pickering Nuclear Generating Station (PNGS). They rest on structurally disturbed Paleozoic sedimentary strata and lie within an area of poorly understood geophysical and structural complexity in the underlying Proterozoic basement (Wallach et al. 1998). PNGS was constructed adjacent to a major population centre (now more than five million people) in the late 1960s largely in ignorance of local and regional geological conditions and well before the plate tectonic paradigm provided a model for basement evolution. The presence and significance of major bedrock lineaments, such as the Central Metasedimentary Belt Boundary Zone (CMBBZ) that passes directly under PNGS, together with several other structures that intersect below Pickering, was not then known. Today, such structures are recognised as being defined by persistent earthquake activity (Mohajer 1991, 1993, 1995; Wallach et al. 1998). A magnitude 3.1 earthquake occurred within 3 km of PNGS on May 24, 2000. Ten smaller magnitude earthquakes have been recorded in the last decade along the structure between Niagara and Pickering by the seismic networks of the Geological Survey of Canada and the United States Geological Survey. The more recently constructed Perry nuclear plant in the U.S.A. was temporarily closed in 1986 by a magnitude 5 temblor along the same CMBBZ structure. The local community has every right to be concerned about the presence of an aging nuclear reactor in their midst. The four Pickering "A" reactors were shutdown in 1997 as a result of "long standing management, process and equipment problems" (NPAG, Nuclear Performance Advisory Group 1997). As part of the recent Environmental Assessment regarding their now much-delayed restart, significant data gaps were identified regarding the environmental setting and impact of PNGS; Ontario Power Generation were urged to complete additional geological and geophysical investigations (City of Pickering 1999). Against this background of uncertainty, any new information regarding the geology of the area is to be welcomed. Unfortunately, Godin et al. (2002) miss much of the current literature on the subject and their interpretations are not in accord with present understanding.

Detailed comments

Godin et al. (2002) have all the hallmarks of having been completed by outside workers unfamiliar with the area in question; their knowledge of existing geological information is at best described as "limited." They use stratigraphic concepts and formal terms (e.g., Bowmanville Till) derived from elsewhere in southern Ontario (Brookfield et al. 1982), long superceded by the results of a wealth of work in the vicinity of the Rouge Valley since 1990. The regional Pleistocene stratigraphy has been established by map, outcrop, seismic, geochemical, and drilling investigations as part of intensive regional searches for landfill sites by the Provincial government and their consultants (Interim Waste Authority 1994a, 1994b, 1994c; Dillon 1994), the Ontario Ministry of Natural Resources (1992), and university researchers (Boyce et al. 1995; Boyce and Eyles 2000; Meriano and Eyles 2003), including seismic profiling (Boyce and Koseoglu 1997). This body of work even documents glaciotectonic deformations associated with late Wisconsin drumlins, directly relevant to their investigation, that are exposed just a few kilometres distance from the Rouge outcrops. Much recent activity has focussed on the detailed geology, geophysics, and hydrogeology of the Northern Till (the Bowmanville Till of Godin et al. 2002) deposited during the maximum of the late Wisconsin glaciation (Nissouri Stade), associated Mackinaw Interstadial sediments (not mentioned by Godin et al. 2002), and the younger Port Huron

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Stade till (Halton Till). Several papers have addressed the detailed stratigraphy and origin of these units (Boyce et al. 1995; Gerber and Howard 1996; Boyce and Eyles 2000). Godin et al. (2002) cite thermoluminescence age dates published in the mid-eighties made redundant by refined results published a decade later (Berger and Eyles 1994). Why cite a reference to till fabric analysis from 1938 and yet another paper published entirely in Latvian? Why waste space repeating now shopworn arguments regarding the origin of the Sunnybrook Drift (p. 1376), when the authors never again refer to this unit? The failure to consider recent relevant work but at the same time emphasise work of little or no relevance, undermines the credibility of their study.

A key element of Godin et al. (2002) is their identification of so-called "drumlinoid features" (black marks on their fig. 1A). They make the argument that these are subglacially produced landforms related to their so-called glaciotectonic structures. It should be noted that no such glacial landforms are present on any detailed map of the area (Karrow 1967; Hewitt 1969; Westgate 1979; Sharpe 1980; Ontario Ministry of Natural Resources 1992; Sharpe and Barnett 1997). Their orientation on Fig. 1A is distinctly random; those depicted on their map near the letters "Ontario lobe ice flow" are man made, part of the Beare Road landfill! Those shown between the deeply downcut Little Rouge and Rouge River are mesa-like terrace remnants of Pleistocene sediment between the deeply downcut rivers (Karrow 1967). The study area as a whole, lies on the eroded and greatly modified floor of a former lake (Glacial Lake Iroquois) and the outcrops in question are all exposed deep within a river valley several tens of metres below the surrounding lake floor. The role of any glaciotectonic deformation during deposition of the Sunnybrook and Meadowcliffe is not mentioned by the authors. The conclusion of Godin et al. 2002 (p. 1389) that "most deformation structures are compatible with local and regional late Wisconsinan (Nissouri phase) ice flow directions to the northwest" (our italics) is incorrect. The Nissouri phase is the main phase of the last glaciation when the Laurentide Ice Sheet reached its maximum southern extent in Ohio with ice flows principally "from the north-northeast" (Barnett 1992, p. 1042; Boyce et al. 1995). The much younger Halton Till from the Port Huron Stadial is associated with northwest-directed ice flows (fig. 12 in Boyce et al. 1995).

Godin et al. (2002, p. 1379) state that they were "not able to uncover much of the Paleozoic bedrock" therby resulting in the collection of "only surficial structural data". This is highly unsatisfactory. Rather than amassing the resources needed to close this rather critical omission, they simply opt to refer to unpublished drilling work by others designed to establish whether bedrock is faulted at depth (Semec 2000). No drill logs or actual data are presented from the cited study for independent verification by the reader. We note that drill sites were located some distance away from the faulted outcrops described by Mohajer et al. (1992); why weren't drill holes located on the outcrops to maximize information? Angled drilling is also required to intersect as many structures as possible. Why was drilling not completed across the much larger offsets (up to 15m) reported close to their site 13 by Mohajer et al. (1995)? These deficiencies are puzzling and unacceptable given the resources available to Ontario Power Generation and their consultants, such as Godin et al.

Godin et al. (2002) argue that the Rouge structures are glaciotectonic but admit that postglacial stream terrace gravels are offset by faults as young as 10 ka (third paragraph, p. 1381) and that these faults "could have a neotectonic origin" (end of paragraph 2, p. 1389). Given the close proximity to PNGS and the known history of earthquake activity, this finding is a matter of the greatest significance. Important advances in understanding the geology of the Rouge Valley area have been made in recent years. Rather than repeating outdated concepts of Quaternary stratigraphy and landform development, the authors should have instead focussed their efforts on designing a proper study based on current information and nomenclature.

Despite its obvious limitations, the report of Godin et al. (2002) is welcomed because it underscores the need for a comprehensive investigation of the geology of the Rouge Valley and the environs of Pickering Nuclear Generating Station. Their principal conclusion, like ours before them, is that geologically recent neotectonic activity close to PNGS cannot be ruled out.

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