number of geological terranes of different ages. Several terranes are of Archean age (the age of the Slave Province). They are welded together by younger terranes that formed in the Proterozoic, between 2500 million and 1000 million years ago.

The Laurentian terranes differ not only in age but also in lithospheric composition, temperature, and thickness. Large-scale geochemical and geophysical studies indicate that the Proterozoic lithosphere is less depleted in iron (*9*) and aluminium (*11*) than the Archean lithosphere. Some Archean tectosphere is thicker than the Proterozoic one but another Archean province, Wyoming, no longer has any thick lithosphere (*5*) (see the figure). On smaller scales, the picture is much more complicated. Moreover, the heterogeneity within Laurentia is not only horizontal. Composition and stiffness also vary with depth, indicating that the formation of Archean and Proterozoic tectosphere was not a simple process.

Models for tectosphere formation and evolution invoke many different processes, such as the cooling of extremely high-temperature mantle melts (for example, from upwelling mantle plumes), the stacking of buoyant Archean lithospheric plates, and processes much like today's plate tectonics, including subduction of the lithosphere. Deep probing of the tectosphere is providing clues as to which of these processes played a role in the evolution of today's lithosphere.

Programs such as Lithoprobe (*12*) have provided important insights into the structure and evolution of continental lithosphere in Canada. Results from Lithoprobe investigations of different parts of the Laurentian crust point to an important role for subduction in the formation and evolution of tectosphere younger than 3000 million years. Laurentia, which is only half the size of North America (see the figure), was assembled by such processes by 1000 million years ago (*10*). Geological similarities between various Archean provinces around the world indicate that a form of plate tectonics may have operated in the Archean, with "protoplates" that were much smaller than Laurentia or present-day tectonic plates. For example, the Slave and Wyoming Provinces may have been part of one larger "protocontinent," Sclavia, together with the Archean Zimbabwe Province of southern Africa and the Dharwar Province in India around 2600 million years ago (*2*). In addition, hot upwellings from the deep mantle may also have contributed to the evolution of the North American tectosphere, for example, in the mid and late Archean (*3*, *7*).

Lithoprobe is one of the main reasons why we now know so much about the Laurentian crust, and continental-scale geophysical studies have provided three-dimensional images of the uppermost mantle beneath Laurentia, although not nearly at the same level of detail as the crustal studies. More research is necessary to establish how Archean and Proterozoic lithosphere formed and evolved. New geophysical experiments need to characterize the Laurentian tectospheric mantle in more detail, for example, through the deployment of dense networks of broadband seismometers. It is also important to broaden our study areas—to include tectosphere worldwide, for example, in southern Africa, and to integrate analyses from multiple disciplines. Focusing and broadening our research efforts in this way will help unravel some of Earth's early geological history.

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13. I thank the organizers and the sponsors of the Slave-Kaapvaal workshop (www.cg.nrcan.gc.ca/slave-kaapvaal-workshop/), Merrickville, Canada, for supporting my participation in the workshop.

NOTA BENE: MICROBIOLOGY

Know Thine Enemy

The anthrax bacillus is enjoying renewed notoriety as an agent of bioterrorism. Inhalation of about 10,000 *Bacillus anthracis* spores causes a systemic form of anthrax that is fatal unless treated immediately with antibiotics. This lethality is principally due to the tripartite toxin produced by the anthrax bacillus. Assembled on the surface of host cells, this toxin is composed of protective antigen (PA) bound to two enzymes, lethal factor (LF) and edema factor (EF), which block macrophage activity. Two recent *Nature* papers identify the host cell receptor for PA (*1*) and reveal the structure of LF (*2*), providing hints about targets for therapeutic intervention in the later stages of the disease.

LF and EF depend on PA for access to their intracellular targets. The PA heptamer enters the cell by endocytosis, taking LF and EF along with it. The low pH of host cell endosomes induces a conformational change in PA, which enables LF and EF to cross the endosomal membrane and to enter the cell cytosol. LF, a metalloprotease, cleaves different isoforms of the MAPKK signaling molecule causing macrophages to lyse; EF, an adenylate cyclase, blocks phagocytosis of anthrax bacilli by macrophages.

The host cell receptor bound by PA is a potential target for therapeutic intervention. Using a genetic complementation approach, Bradley *et al.* (*1*) show that the cellular receptor for PA (called ATR) is a type I integral plasma membrane protein of unknown function that contains an extracellular von Willebrand type A (VWA) domain. Soluble VWA can block binding of PA to ATR suggesting one strategy for preventing toxin entry (assuming that ATR is the only cellular receptor).

Pannifer and colleagues (*2*) have refined the crystal structure of LF to 2.2 Å resolution. Of LF's four domains, domain I contains a docking site for PA, and domains II and III interact with domain IV to form an extended binding pocket that is specific for the MAPKKs. With the LF structure in hand, it should be possible to screen small molecules for their ability to block binding of MAPKKs to LF. Neutralizing the effects of LF could provide a therapeutic means for treating the systemic stages of the disease.

As an added bonus, understanding how the anthrax toxin enters cells should help in fine tuning lethal toxin, a combination of PA and LF, which has proven to be an effective antitumor agent in the test tube and in animals. **–ORLA SMITH**

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