August 9, 2021

News and Notes

Before going on to the main posting for this week, here are a few news items I thought might be interesting:

- An interesting interdisciplinary study in Kentucky, a collaboration between geologists and public health nurses to map the potential for radon exposure. The highest risks were associated with Mississippian age limestone bedrock.
- Things might be heating up in Yellowstone Park: More Than 1,000 Earthquakes Swarmed Yellowstone Park Last Month; this could be a minor fluctuation in the Yellowstone Caldera system, or it could mark a major change. A large eruption of Yellowstone would be a major disaster for the world and would likely lead to a major de-population of the North American continent.
- More on the Yellowstone Caldera, Don't Call It a Supervolcano; a good summary of what geologists have discovered about Yellowstone.
- Following up on my July 26, 2021 posting on fluvial depositional environments, this recent paper (behind a pay wall), Linking rivers to the rock record: Channel patterns and paleocurrent circular variance, discusses the variability of sediment deposition by rivers.
- Here is an ongoing issue, burying carbon dioxide (CO_2) from power plants to remove it from the general environment and reduce the growth in CO_2 concentrations in the atmosphere: Burying CO2 deep in ND's geology may combat climate change. Is it financially feasible? The economics seem to depend on what kind of government subsidies are available for the practice. CO_2 is also used in tertiary production techniques for depleted oil fields.
- Dr. Hamid Mumin at Brandon University has some exciting news: "It is my pleasure to inform you that the Geological Association of Canada/Mineralogical Association of Canada has selected Brandon University as the site for the 2024 GAC-MAC Annual Meeting. The meeting will be co-hosted by BU, U of M and UCN-NMMA. We expect between 400 to 500 persons from across Canada to Attend. GAC-MAC generally takes place in May. The meeting Chair is Paul Alexandre, with Anton Chakhmouradian and myself as co-Chairs. We invite and encourage both the MPDA and CCMEC to join us as sponsors, participants, and/or major participants. We encourage you to even think about having a CCMEC event at that time in Brandon, taking advantage of the hundreds of additional geologists and participants from across the country." **Note**: this year's GAC-MAC 2021 Joint Annual Meeting will be in London, Ontario November 1-5.

August 9, 2021

Depositional Environments for Sedimentary Rocks, Part 5, Lakes and Salt Flats

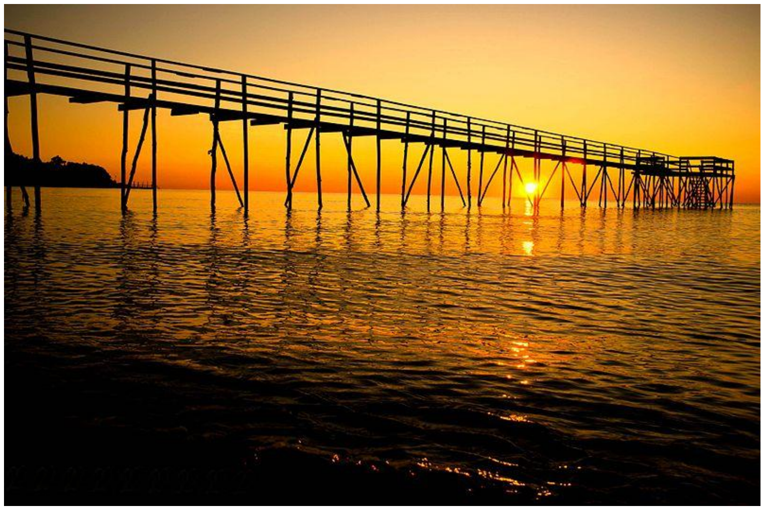

Figure 1 - Lake Winnipeg at Sunrise
Credit: Vince pahkala, Creative Commons Attribution-Share Alike 3.0 Unported license

We'll finish up terrestrial depositional environments for sedimentary rocks with a discussion of deposition of sediments in lakes and salt flats: i.e. lacustrine and evaporite depositional environments.

Table 1 Terrestrial Depositional Environments

Environment	Key Transport Processes	Depositional Settings	Typical Sediments
Glacial	Gravity, moving ice, moving water	Valleys, plains, streams, lakes	Glacial till, gravel, sand, silt, clay
Alluvial	Gravity, moving water	Where steep-sided valleys meet plains	Coarse angular fragments
Fluvial	Moving water	Streams	Gravel, sand, silt, organic matter
Aeolian	Wind	Deserts and coastal regions	Sand, silt
Lacustrine	Moving Water	Lakes	Sand, silt, clay, organic matter
Evaporite	Still water	Lakes in arid regions	Salts, clay

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Lacustrine Environments

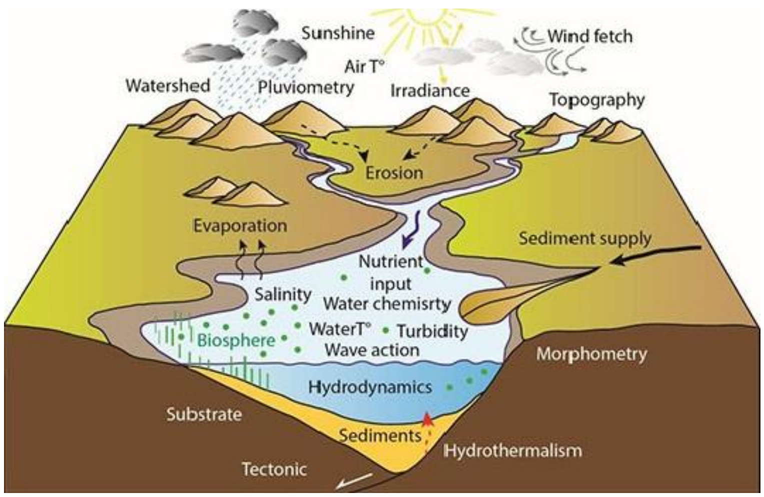

Figure 2 - Lacustrine Systems
Credit: Lettéron, 2017 [1]

Lakes are complex, dynamic systems that have a variety of environmental influences. These influences include:

- The underlying and surrounding geology and geomorphology: is it in a plain, a mountain valley, an open or closed basin?
- The climate zone that the lake is located in: hot, cold, wet or dry?
- The amount and sources of water entering the lake: e.g. from rainfall, meltwater runoff, groundwater seepage.
- How much water enters and leaves the lake?
- The amount of water lost to evaporation and the amount that leaves by river(s) that drain the lake.
- The depth of the lake: shallow or deep?
- Water chemistry, is the lake fairly fresh or is it saline?
- What are the effects of wave action and internal currents?

All of these factors will affect the kinds of sediments deposited in the lake. Figure 3 is a ternary diagram that illustrates the principal types of lacustrine deposits.

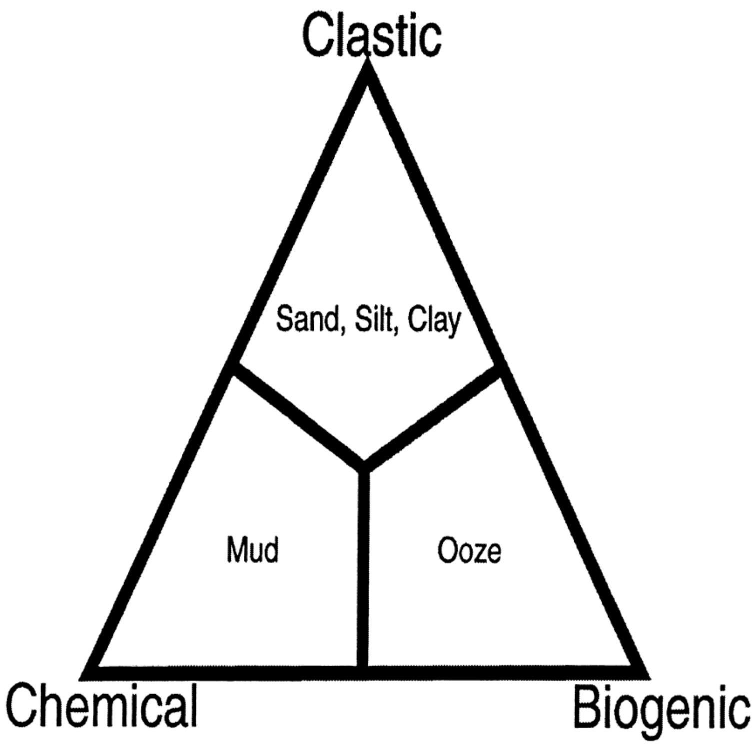

Figure 3 - Principal Types of Lacustrine Sediment
Credit: Schnurrenberger, Russell & Kelts, 2003 [2]

Clastic Sediments

Figure 4 - Delta Beach, Manitoba
Credit: Shahnoor Habib Munmun, Creative Commons Attribution 3.0 Unported license

Clastic sediments are the most common kind of sediment deposited in lacustrine environments. As we discussed on July 26 with fluvial environments, the relative amount of sand, silt and clay deposited will depend on the amount of energy in the environment. For example:

- Sand will likely be deposited where rivers enter the lake, dropping their load of sand and silt.
- Sand can also be deposited on beaches, as in Figure 4, high energy environments where wave action washes away silt and clay.
- The deep, still water of the lake basin is likely to be the repository for clay and silt, this is a low energy environment.

Chemical Sediments

Figure 5 - Bonneville Salt Flats

Chemical sediments are evaporites deposits such as gypsum, potash and common salt together with carbonates such as limestone, dolomite and carbonate mud.

We looked at evaporite deposits in the May 31, 2021 posting, but we can talk a bit more about them in the context of lacustrine deposits and salt flats. If a lake forms in a basin with little or no outlet, such as the Great Salt Lake in Utah or the Dead Sea between Israel and Jordan, we can expect the lake to become saline. This is especially the case where the lake is located in a desert. Evaporites can become deposited when the lake completely dries out, such as in the case of Glacial Lake Bonneville, now called the Bonneville Salt Flats. Subsequent burial can result in evaporite deposits. Lagoons on the edges of a salt lake can become places where evaporite deposits form. The particular chemistry of the salt lake, and any surrounding lagoons, will determine what kind of evaporites are deposited.

In some cases, chemical precipitation of calcium carbonate (calcite and aragonite) and calcium-magnesium carbonate (dolomite) can occur in a lake basin, if the chemistry is right. The process begins with the entry of water saturated with calcium carbonate and/or magnesium carbonate, which is often groundwater. When the concentration of carbonates in the lake water exceeds the solubility for those minerals, carbonate minerals will precipitate. This process has been documented at Lake Constance in Switzerland where the trigger for precipitation of carbonates appears to be algae acting as nucleating agents.

When precipitated carbonates mix with clay, the result is a calcareous shale or a marl.

Biogenic Sediments

Figure 6 - Peat Bog, Jardins de Métis, Québec
Credit: Creative Commons Attribution 2.0 Generic license

Biogenic sediments include organic deposits such as peat, organic ooze and sediments from fossil material.

In the current Quaternary Period, peat forms on the edges of lakes in cold climates from the growth and accumulation of sphagnum moss. In some cases, the moss can overgrow the whole lake to form a floating bog. Some floating bogs are tourist attractions. The sensation of walking on a floating bog is like being on a water bed. Just don't fall through, or you could end up like one of the bodies of sacrificial victims buried in bogs during the Bronze Age.

At other times in Earth's history, such as the Carboniferous Period, other kinds of aquatic vegetation such as ferns, formed peat. When the peat became buried and compacted by about 10 times, the result was coal.

Related to peat are other carbonaceous deposits that form an organic ooze at the bottom of lakes. When a lake is deep enough, the bottom can be anoxic (i.e. lacking dissolved oxygen). When plankton and other suspended biota die, they can fall to the bottom of the lake before they are recycled by other creatures. Over time, a black, carbonaceous ooze can accumulate. Mixed with clastic sediments, this can form organic clays and eventually oil bearing shales.

Fossiliferous sediment consists of the remains of the hard parts of organisms that live in the lake, either in the pelagic (free floating) or in the benthic (lake bottom) zones. These organisms range in size from microscopic plankton to the remains of more familiar creatures such as clams and mussels. The fossiliferous sediment can be made up of the remains of siliceous (made of silica), chitinous (made of chitin, think shrimp shells) and calcareous shelled organisms.

A familiar example of fossiliferous sediment is diatomaceous earth, which is made up of the siliceous skeletons of diatoms, a kind of algae that excrete skeletons made out of silica. I've been using diatomaceous earth to control Colorado Potato Beetles in my garden this year, with limited success.

Standard Caveat

The purpose of my weblog postings is to spark people's curiosity in geology. Don't entirely believe me until you've done your own research and checked the evidence. If I have sparked your curiosity in the subject of this posting, follow up with some of the links provided here. If you want to, go out into the field and examine some rocks on your own with the help of a good field guide. Follow the evidence and make up your own mind.

In science, the only authority is the evidence.

References

1. Alexandre Lettéron, 2017, *Sedimentological, stratigraphic and paleoenvironmental characterization of the variable salinity lacustrine carbonate system of the Alès Basin and bordering regions (Priabonian, S-E France): paleoclimatic and paleogeographic implications*, IFP Energies Nouvelles, https://www.ifpenergiesnouvelles.com/brief/lacustrine-sedimentary-series-archive-past-environmental-changes-better-understand-present

2. Douglas Schnurrenberger , James Russell and Kerry Kelts, 2003, *Classification of lacustrine sediments based on sedimentary components*, Journal of Paleolimnology 29: 141–154, 2003, http://lrc.geo.umn.edu/laccore/assets/pdf/sops/sedclass.pdf