Virtual Tour
"Wandering the Sparkill Watershed"

by Dr. Michael J. Passow

NOTES ABOUT THE SPARKILL/PIERMONT REGION
TO ACCOMPANY "WANDERING THE WATERSHED" KAYAKING TRIP

Geological Setting

The region in which we will be paddling has a very interesting and not entirely clear geologic history, one that has been extensively studied for decades without reaching consensus.

The dominant features are the igneous rocks forming the Palisades of the Newark Lowlands on the western side of the Hudson River and the much older metamorphic rocks of the Manhattan Prong on the eastern side. The Sparkill Gap, from which we set out, is one of the largest breaks in the Palisades.

But beneath such simplicity lie many questions. What is the connection between the Sparkill Gap and the river? Why are the tops of the Palisades south of the Gap much smoother than north of the Gap? What is the relationship between the Paleozoic and Precambrian rocks in Westchester and the Mesozoic rocks in Rockland? What were the effects of Pleistocene glaciations?

Many of these questions have been explored during field excursions sponsored by the New York State Geological Association. Three guidebooks in particular are of use for studying this region, and should be consulted for more details:

40th Meeting (1968) Queens College, CUNY

47th Meeting (1975) Hofstra University

52nd Meeting (1980) Rutgers-Newark

More information about the availability of these and other volumes is found at www.nysgaonline.com.

Here are some excerpts from some of the write-ups of relevance in the area we are exploring today. (Note: References have generally been omitted, but some dates for publications have been provided for historical interest.)

1968 "Trip C: The Triassic Rocks of the Northern Newark Basin" by E. Lynn Savage, Brooklyn College, with "Road Log" by F.B. Van Houten and E.L. Savage

p. 81: Sparkill (formerly Overpeck) Creek in the gorge is the only stream that flows eastward across the Palisade Sill into the Hudson River. Presumably it flows along a cross-fault (such as seen at Lincoln Tunnel plaza) that has offset the sill more than 900 feet westward on the north side.

According to Johnson (1931) the Hudson River originally flowed southwestward on the Schooley erosion surface above the position of the sill, was superimposed on it and cut a water gap. (Figure 17) Later a subsequent stream flowing on relatively non-resistant rocks east of the sill captured the ancient Hudson drainage by headward erosion. Overpeck Creek then reversed the original drainage direction. This explanation does not account for the coincidence of the gap and a cross-fault.

Between Piermont and Nyack beach State Park, there are many outcrops and abandoned quarries of "brownstone" which was used extensively for building-stone more than 50 years ago. Most of the rock is a dark brown to reddish-brown well-sorted medium to fine-grained arkose, commonly interbedded with reddish brown mudstone. Some of the lighter colored arkose is coarser grained, but conglomerate is rare. Presumably these deposits are a gradational sequence between the uppermost part of the Stockton Formation and the lower part of the Brunswick Formation, and differ in heavy mineral content, sedimentary-metamorphic rock content, and dispersal direction from those in the upper part of the Stockton Formation.

1975 Trip A-2 "Structure and Form of the Triassic Basalts in North Central New Jersey" by Michael Sichko, Jr.

p. 1 "The Palisadian Igneous Province"

The igneous rocks and their counterparts in the other Triassic basins record the emplacement of basic magma on an enormous scale, 1,000 miles in length and about 200 miles wide. Significantly, they correlate broadly with the vast Karoo dolerites and equivalent basic rocks in the Southern Hemisphere, and like them, apparently were emplaced during an episode of tension attending the widening of the Atlantic.

[The Palisades Sill intrudes the Stockton Formation, consisting of gray to red arkosic sandstone, conglomerate, and red shale.] The age of the Palisades sill has been determined by Erickson and Kulp (1961) at 190 +/- 5 m.y. by a K-Ar determination on biotite from dolerite at Fort Lee.

It has been established that the Palisades Sill is a multiple intrusion comprising at least two magma phases, into which later-stage dikes intruded after the main phases consolidated. This seems reasonable, as the contemporaneous Watchung basalt flows, with three main basaltic successions, show that igneous activity at the time was protracted and comprised a number of phases.

The differentiation of the sill is a complex one of interacting processes, both mechanical and chemical. The conditions and processes responsible for the differentiation of the sill are outlined below:

1. temperature
2. pressure
3. magma composition
4. settling by gravity

5. upward displacement of the liquid phase
6. gas streaming
7. convection
8. flow differentiation
9. filter pressing
10. partial pressure of oxygen
11. volatile content, particularly water

1980 "Late Wisconsin-Holocene History of the Lower Hudson region: New Evidence from the Hackensack and Hudson River Valleys" by Stephen P. Averill, Richard R. Pardi, Walter S. Newman, and Robert J. Dineen

p. 162 "Sparkill Gap Seismic Study"

Sparkill Gap has been most important to the late and postglacial of the Hackensack. It breaches the otherwise continuous wall of the Palisades that extends from Jersey City, New Jersey to Haverstraw, New York. Because of the northward glacially induced isostatic crustal tilt, it served as the drainage for the Hackensack River on several occasions.

Sparkill Gap is underlain by the Triassic Palisades Formation. These sandstones and shales are cut by several northeast-southwest trending normal faults. Sparkill Gap is on the north end of a +180 ft. to +200 ft. above sea level terrace that was eroded by the southwest-flowing preglacial Hudson River. The preglacial Hudson was consequent on a graben that broke the crest line of the Palisades ridge. The Tappan and Sparkill Moraines lie west of the Gap; these moraines were deposited by ice lying in the valley between Orangeburg and Mt. Nebo. Stratifies drift (outwash) lies between the two moraines.

The Gap is filled by over 60 ft. of glacial drift, based on test borings and water wells.

p. 175 "The Piermont Tidal Marsh"

The Piermont estuarine tidal marsh fringe abuts the Palisades ridge along the west shore of the Hudson Estuary between the Piermont Pier on the north and Sneden Landing on the south (Fig. 2a). The marsh exactly spans the 3 kilometer wide Sparkill Gap. The marsh is about 0.6 kilometers wide at its northern end and tapers to a feather edge at its southern terminus. Although examination of the Nyack 7-1/2 minute quadrangle sheet suggests that the marsh developed as the delta of Sparkill Creek in the apex bounded by the Palisades Ridge on the west and the Piermont Pier on the north, our boring program within the marsh indicates that a portion of the marsh has been in existence for at least several thousand years. The Piermont Pier was built as the eastern terminus of the Erie Railroad in 1841. An 188 map of the area, when compared with the most recent topographic map of the area, indicates that the marsh has gained about 25% in area during a 73 year interval.

According to Lehr (1967), the Piermont tidal marsh contains the most northerly concentration of true halophytes in the Hudson estuary. Adjacent to the road at the base of the Palisades escarpment, the marsh is dominated by cattail while the marsh adjacent to the estuary is covered with *Spartina spp.* with minor amounts of other salt marsh halophytes. … The marsh surface appears essentially in equilibrium with contemporary sea level and forms a convenient reference datum.

… Concluding the section, the sea level data obtained from the Piermont Marsh demonstrates that the Hudson Estuary has been in existence for at least 7,000 radiocarbon years and has witnessed a generally transgressive mode for much of this interval. Paradoxically, our micropaleontological data suggest that the estuary is perhaps less saline today than it was during mid-Holocene times. We believe that the valley has been shoaling more rapidly that the sea has been rising thus reducing the cross-sectional area of the estuary and attenuating the penetration of the salt-water wedge intrusion upstream.

LDEO Hudson River Studies

Robin Elizabeth Bell, Dorothy Peteet, and others of the LDEO Hudson River Group have made extensive investigations into many aspects of the river in recent years. These were the themes for Earth2Class Workshops in March 2002, March 2003, and February 2004. Some of this work has been done through the Columbia Earth Institute's Center for Rivers and Estuaries. LDEO scientists also participate in the annual "Hudson River Snapshot Day."

Among areas of Hudson River research conducted by LDEO scientists are:

- sediment processes and bottom environments
- currents, mixing, and sediment transport
- transport, mixing, and gas exchange,
- oyster beds and climate history
- ecosystems and carbon cycle
- watershed scale environmental change
- human disturbances

Two abstracts about their discoveries are of particular interest for our trip.

"Rapid Late-glacial Climate Change in Hudson Watershed"
Principal investigators: Dorothy Peteet and Linda Heusser

After ice sheet retreat atop the Palisades of the Hudson River, Alpine Swamp, Alpine New Jersey (41 N 74 W) records a 12,500 C-14 year history of vegetational and climatic change. The first arrival of trees to the area included spruce, which was followed by deciduous hardwoods, and the forest became a mixture of boreal and deciduous species around 11,000 years ago. A dramatic cold event called the Younger Dryas ensued, lasting until about 10,000 years ago. This cold reversal was marked in the Hudson region by an expansion of the boreal forest (spruce, paper birch, fir, alder) and the decline of the warmth-loving trees (oak, ash, white pine). The return of the warm trees at 10,000 years ago was extremely rapid, and the boreal trees died out within a century. The timing of this event is synchronous with the same cold event in Europe, Greenland, and the North Atlantic. [Peteet, D., et al, 1993, "Late-glacial pollen, macrofossils, and fish remains in northeastern USA—the Younger Dryas oscillation. Quaternary Science Reviews 12: 597-612.]

"Environmental History of the Piermont Marsh, Hudson River, NY"
Principal Investigators: Dorothy Peteet and Jennifer Wong.

An 11-meter core from Piermont Marsh, New York, was retrieved from the northern mid-marsh region and dates to about 4,200 C-14 years. The rate of deposition in the marsh is about 0.26 cm/yr throughout. A low-resolution profile of pollen, plant macrofossils, and charcoal reveals major changes in vegetation throughout the marsh history. Earliest samples reveal a dominance of hemlock, while about 3,000 years ago, the profiles are dominated by pine. Most recent sediments show anthropogenic influence with the dominance of giant reed (Phragmites) seeds replacing the cattail marsh (Typha). Foraminifera macrofossils reveal a history of oscillations between low and high marsh environments. Further high-resolution research is ongoing. [Wong, J., and Peteet, D., 1998, "Environmental history of Piermont Marsh, Hudson River, NY. Section III, 30. In W.C. Nieder and J.R. Waldman (eds.), Final Reports of the Tibor T. Polgar Fellowship Program, Hudson River Foundation.]

Tides and River Structure

Strictly speaking, this portion of the Hudson is not a "river," but rather a "tidal estuary." Rivers flow from their head to their mouth, either joining another river or lake, or entering the ocean. Many streams also have steep to gentle gradients as they drop from their source to their outlet. But the Hudson from Albany southward is basically at sea level and experiences twice-daily tidal flows of more than a meter.

Predicted tidal information—times for high and low tides and expected heights above datum level—can be found at http://tidesandcurrents.noaa.gov/tide_predictions.html.

When we make our paddle on May 23, 2015, predictions for Tarrytown (about two miles north across the river) are:

2:33 a.m.	High 3.23 feet above datum level
9:11 a.m.	Low 0.24
3:20 p.m.	High 3/15
9:17 p.m.	Low 0.72

The Moon is in the "waxing crescent" phase (between New Moon and First Quarter), so these are neither especially high nor especially low levels. Moonrise today will be at 10:43 am and set at 12:41 am on Sunday. Sunrise is 5:31 and sunset at 8:14. These data are provided by the "Nation's Official Timekeeoers," The U.S. Naval Observatory (http://aa.usno.navy.mil/data/docs/RS_OneDay.php).

As a consequence of these tidal patterns, water levels and surface currents in the river need to be understood by paddlers. They can be strong enough to impede or enhance a trip greatly, although at other times be negligible.

The NOS also provides predicted current flow (http://tidesandcurrents.noaa.gov/noaacurrents/Regions.) Although maximum currents in this area are a little more than 1 knot, wind conditions can add or diminish the rate at the surface where we paddle, as well as build up waves. However, most of our trip will be in the protected area of the Tallman Salt Marsh.

For the portion from about Kingston southward, the river also has a two-layer structure involving an upper freshwater layer and a lower saltwater layer. The location of this "saltwater wedge" varies depending on precipitation and other factors. The salt front is defined as 100 mg/L chloride concentration, so seasonal precipitation variations, droughts, and heavy rainfall can easily affect the location. Current position can be found through the US Geological Survey "Salt Front" data (http://ny.water.usgs.gov/projects/dialer_plots/hsfloc.gif). During the past decade, the position has fluctuated from less than 15 miles above the Battery to more than 80, placing it north of Poughkeepsie.

The U.S. Environmental Protection Administration's (E.P.A.) "Surf Your Watershed" (http://www.epa.gov/surf/) contains resouces about the hydrology of our country. The "Lower Hudson" watershed can be found at http://cfpub.epa.gov/surf/huc.cfm?huc_code=02030101. You can learn about many other hydrologic variables from this web site, as well as make comparisons with adjacent or distant watershed.

Final Thoughts

We hope these notes will stimulate you to learn more about the area, whether or not you are observing it while paddling or on-shore. Many other questions can be developed that could serve as the basis for future investigations by you and your students.

Remember: "The real classroom is outside—get into it!"

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