Adolf Morlot:

the Measure of Quaternary Time

Slide 2 MAP

In September 1856 the engineers building the railroad around the eastern end of Lake Geneva in Switzerland began a cutting through the cone-shaped delta of the Tinière, a swift-running stream descending from the mountains east of the lake at Villeneuve. The Tinière had carved out its valley along the crest of an anticlinal fold in Secondary and Tertiary strata. In the recent geological past, Lake Geneva had stood at higher levels, about 50, 100, and 150 feet above the present level of the lake, marked by

Slide 3 Lubbock drawing

terraces running parallel to the lake shore. Mountain streams, like the Tinière, cut through these terraces to form cone-shaped deltas at the lake shore.

The railway cutting at Villeneuve attracted the attention of Adolf Morlot, a young professor of geology a the Academy of Lausanne. After

studying at the School of Mines at Freiberg in Germany, Morlot went about 1846 toVienna, where he worked with Wilhelm Haidinger (1795–1871), founder of the Austrian Geological Survey. In 1851 Morlot came to Lausanne, where he began to study the effects of glaciation in Switzerland.

Slide 4 Clarens section

In a ravine at Clarens, a hamlet on the shore of Lake Geneva north of Villeneuve, Morlot found a stratified alluvium overlaying glacial clay. Above the alluvium was a second glacial deposit, thicker than the lower one. Morlot decided that the two glacial deposits, one above the other represented two glacial periods, separated by an intervening warmer period.[1]

If the Quaternary were separable into distinct periods, Morlot was eager to learn what a section through the Tinière cone might tell of the most recent period. By 1859 the engineers had carried their cutting about

Slide 5 Tinière cut for aqueduct

500 feet through the southern part of the Tinière cone. They stopped short of the Tinière stream itself. In order to proceed further they needed to build

an aqueduct to carry the Tinière water over the railway line. The cutting was quite narrow, intended for the railway line only, and at its deepest point about 23 feet deep. At Villeneuve they excavated a wider area for the railway station and to obtain gravel for ballast along the line.

Slide 6 Completed Tinière cut 1860

In the sides of the cutting, Morlot found four feet below the present surface of the cone a former soil containing broken pieces of Roman tiles and a Roman medal. The soil appeared to date from the Roman period which lasted in Switzerland from the beginning of the first century until about the year 563.

Ten feet below the surface was a second former soil containing a bronze object and pieces of Bronze-age pottery. Finally, 19 feet below the surface was a third former soil marked by much charcoal, pieces of coarse pottery, and animal bones. The site appeared to have been inhabited for a long time. Morlot placed it in the Stone Age.

Slide 7 cross section of cone

From the uniform composition of the interior of the Tinière cone,

Morlot concluded that over the centuries it had maintained a fairly constant rate of growth. Nevertheless, as the cone enlarged, its rate of growth must decline. While the Tinière brought down a steady quantity of sediment, the cone grew in proportion to the cube of its radius. Allowing for such factors, Morlot calculated that in the 10 to 15 centuries since the Roman period, the Tinière had deposited three feet of sediment over the cone surface. On that basis, he calculated that the Bronze Age soil was between 2,900 and 4,200 years old, and the Stone Age soil 4,700 to 7,000 years, but these figures represented minimum rather than maximum ages. Floods on the Tinière must have rendered the cone's surface uninhabitable for long periods of time.

Slide 8 Morlot and Lyell portraits

Morlot had met Sir Charles Lyell when Lyell visited Lausanne in the summer of 1857 and in March 1860 he sent Lyell his calculations of the antiquity of the Bronze and Stone Ages. Lyell replied immediately: "I am very glad that you have made that Tinière calculation. Some one must have the chivalry to begin & not mind being abused."[2]

Morlot did suffer abuse from religious leaders at Lausanne, but in 1860 he returned to Villeneuve to study further the Tinière cone. The engineers had now completed an aqueduct to carry the Tinière water above the railway line and had extended the cutting right through the cone. It was now 1,000 feet long and its greatest depth was 30 feet. The Stone Age stratum extended along its whole length. The Bronze Age and Roman strata were similarly well defined through the whole cutting.[3] Morlot calculated a minimum age of 2,900 years for the Bronze-Age stratum, 4,700 years for the Stone-Age stratum, and 7,000 years for the whole Tinière cone.

Slide 8 older and higher cone

The Tinière had also a similar much larger cone behind and above the modern one, formed when Lake Geneva stood fifty feet above its present level. The larger size of the higher cone showed, said Morlot, "how short the modern period has been, as compared with the diluvial period."[4] The higher cone was at least ten times larger than the modern cone and, therefore, ten times older. Morlot estimated its age to be at least 100,000

years.[5]

Morlot also thought it might be a measure of time since the retreat of the great glaciers, when the mammoth lived in Europe, and man appeared there.[6]

Danish archaeologists had identified the succession of Stone, Bronze, and Iron Ages in Europe, but Morlot provided the earliest estimates of the time periods each age might represent. His figures were tentative, but they did approach the right order of magnitude. Morlot demonstrated also the length and complexity of the Quaternary. If included at least two glacial periods of uneven length and an intervening warm period.

Endnotes

1. A. Morlot, Note sur la subdivision du terrain quaternaire de Suiss," *Bibliothèque Univeselle de Genève. Archives des Sciences Physiques et Naturelles,* 1855, 29: 33–50.

2. Morlot to Lyell, 1 March 1860. Lyell MSS, University of Edinburgh Library; Lyell to Morlot, 5 March 1860, Morlot MSS, Bergbibliothek, Bern.

3. Morlot to Lyell, 30 January 861. Lyell MSS, University of Edinburgh Library.

4. Morlot to Lyell, 10 May 1861. Lyell MSS, University of Edinburgh Libary.

5. Morlot to Lyell, 21 February 1862. Lyell MSS, University of Edinburgh Library.

6. A. Morlot, A date of absolute chronology in geology, [Meeting of the Society for Natural Philosophy of Lausanne, 15 January 1862].