*by Clifford M. Nelson**

The Fifth International Geological Congress, Washington, 1891

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The 5th International Geological Congress (IGC), the initial meeting in North America, was the first of the three IGCs that have been held in the United States of America (USA). Of the 538 registrants alive when the 5th IGC convened in Washington, 251 persons, representing fifteen countries, actually attended the meeting. These participants included 173 people from the USA, of whom forty-two represented the US Geological Survey (USGS). Fourteen of the US State geological surveys sent representatives to Washington. Eight participants came from other countries in the Western Hemisphere — Canada (3), Chile (1), Mexico (3), and Peru (1). The sixty-six European geologists and naturalists at the 5th IGC represented Austro-Hungary (3), Belgium (3), Britain (12), France (7), Germany (23), Norway (1), Romania (3), Russia (8), Sweden (4), and Switzerland (2). The USGS and the Columbian College (now the George Washington University) acted as the principal hosts. The American Association for the Advancement of Science and then the Geological Society of America (GSA) met in the Capital immediately before the Congress convened (26 August–1 September 1891).

The 5th IGC's formal discussions treated the genetic classification of Pleistocene rocks, the chronological correlation of clastic rocks, and the international standardization of colors, symbols, and names used on geologic maps. The third of those topics continued key debates at the 1st through 4th IGCs. The GSA, the Korean Embassy, the Smithsonian Institution's US National Museum, the USGS, and one of the two Secretaries-General hosted evening receptions. Field excursions examined Paleozoic exposures in New York (18–25 August), Cretaceous–Pleistocene localities along the Potomac River south of Washington (30 August), and classic Precambrian-Pleistocene sequences and structures in the Great Plains, Yellowstone, Rocky Mountains, and Great Basin (2–26 September), with optional trips to the Grand Canyon (19–28 September) and Lake Superior (23 September–2 October). The single-volume report of the 5th IGC was published in Washington in 1893.

Prologue: invitations in 1888 for the 5th IGC

When meeting in London during 17–22 September 1888, the 4th International Geological Congress (IGC) received three invitations to hold the next triennial congress at cities in the United States and a fourth to convene the 6th IGC in Vienna in 1894. On 19 September, Persifor Frazer (Franklin Institute), the Secretary of the American Association for the Advancement of Science's (AAAS) Special Committee on the International Congress of Geologists, introduced a multi-party offer from Philadelphia to host the 5th IGC. The invitations to meet in the United States (US) had been expected ever since the AAAS reestablished its 'American Committee' in 1882, with James Hall (State Geologist of New York) as Chairman and Thomas Hunt (New York City) as Secretary (Saunders, 1883: 634). The 3rd IGC, held in Berlin in 1885, had recorded an invitation from an unnamed representative of American institutions of higher learning and research, but not a member of the AAAS American Committee, to hold the 5th IGC in Philadelphia, an earlier, but now smaller, center of science in the USA than Washington. Frazer, a member of the American Committee since 1885 and its Secretary since 1886, now urged the 4th IGC to choose Philadelphia, principally to honor the original AAAS American (or 'Founding') Committee of 1876–1880 during the University of Pennsylvania's centennial celebration in 1891 (Frazer, 1888b; Dana, 1888a; Frazer, 1889: 54–55; Hulke and Topley, 1891: 49–50). A second and anonymous invitation from New York City also arrived in London.

On 20 September, Giovanni Capellini (Bologna) suggested to the IGC's Council that it choose a new committee of Americans and let it select the location for the 5th IGC. The Council promptly established an American Provisional (Organising) Committee for the IGC, composed of Hall, James Dana (Yale), Frazer, Grove Karl Gilbert (USGS), Hunt, Othniel Charles Marsh (Yale and USGS), John Newberry (Columbia and USGS, Chairman), and Charles Walcott (USGS). The Council charged them with forming a permanent committee to organize the 5th IGC. Later that day, five members of the Provisional Committee favored Philadelphia over Washington by a vote of three (Hunt, Frazer, and Walcott) to two (Gilbert and Marsh) and they then made the choice unanimous. Frazer transmitted the committee's decision to the Council on 21 September, on which day the Council also received by cable an offer from John Powell, Director of the USGS since 1881, to stage the 5th IGC in Washington. Joseph Prestwich (Oxford), the 4th IGC's President, read Powell's message to the attendees. Prestwich's reply thanked Powell, but added that the Council had already approved the choice of Philadelphia and had so informed its mayor.

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Preliminary planning, 1888–1889

As arranged in London, the IGC's American Provisional (Organising) Committee held its initial (and, in the event, its only) meeting in the US on 13 November, 1888. The Provisional Committee convened, with all official members present except Hunt, while the National Academy of Sciences (NAS) met in New Haven. There, the seven attending members formed a third American committee, the IGC's American Permanent Committee of Organisation, by casting twenty-five votes each for names on a list of eminent American geologists. The persons receiving a majority of the votes formed the new (twenty-four-member) committee (Dana, 1888b). Of those elected, George Cook (State Geologist of New Jersey), Dana, Gilbert, Hall, Charles Hitchcock (Dartmouth and State Geologist of New Hampshire), Peter Lesley (State Geologist of Pennsylvania), Newberry (Temporary Chairman), John Stevenson (City University of New York), and Henry Williams (Cornell and USGS) also still served on the AAAS American Committee.

The other fifteen members of the IGC's American Permanent Committee of Organisation included Charles Ashburner (a veteran of the California and Pennsylvania State Surveys, then consulting for Westinghouse), John Branner (Indiana University), Thomas Chrowder Chamberlin (USGS and President of the University of Wisconsin), William Davis (Harvard), Clarence Dutton (a Captain of Army Ordnance detailed to the USGS), Angelo Heilprin (Philadelphia's Wagner Free Institute), Joseph Le Conte (University of California-Berkeley), Joseph Leidy (University of Pennsylvania), Marsh, Powell, John Procter (State Geologist of Kentucky), Nathaniel Shaler (Harvard), Walcott, Robert Whitfield (American Museum of Natural History), and Alexander Winchell (University of Michigan). Of the new committee's twenty-four members, ten were employed by or affiliated with the USGS. Philadelphia's Edward Cope (Marsh's bitter rival in vertebrate palaeontology) and Frazer remained on the AAAS American Committee, but Hunt resigned from that body. Dana rejoiced to see the trio excluded from the permanent organizers of the 5th IGC.

On 23 November, Powell complained in a letter to Dana that his (Powell's) name had been attached "in an unfair and improper manner" (Powell, 1888: 476a) to the AAAS American Committee's stratigraphic reports presented at the 4th IGC (Frazer, 1888a; Dana, 1888c; Hulke and Topley, 1891: Appendix A). Having resigned from that committee, Powell did not approve of, or subscribe to, its reports. Rather, echoing Gilbert, he stressed that usage could not properly be determined by a vote of any deliberative body, but depended fundamentally on generalizations from observed facts. As the committee's reports, Powell claimed, did not use the USGS nomenclature, he could not accept the reports without being "made virtually to condemn the work of all my assistants" (*ibid*.: 476c). Powell believed nomenclatorial schemes could only apply to geologic provinces and not countrywide, though they might be referred to a "general time scale" (*ibid*.). The required systematic geological conventions and common language could not be sustained, Powell asserted, if many geologists opposed them. They must, he concluded, evolve for the best common future use, rather than be decided by a committee.

In response to the reports, Powell convened a USGS internal conference on map publication, during 28–31 January 1889, to answer thirty-two previously circulated questions. Powell led the discussions by Whitman Cross, George Eldridge, Franklin Emmons, Gilbert (Chief Geologist), Arnold Hague, Joseph Iddings, William John McGee, Raphael Pumpelly, Charles Van Hise, Walcott, George Williams (Johns Hopkins and USGS), Bailey Willis, and four other USGS geologists. To serve the USGS and American uses best, as the participants claimed, they agreed to begin work on a standard *Geologic Atlas of the United States*, each future folio of which would include topographic, geologic, and Pleistocene (or soil) maps (at 1:62,500 east of the Mississippi and 1:125,000 west of that river), structure sections, and descriptive texts. The map-scheme used therein combined solid colors (tint and tone), overprinted colors and patterns (for fossiliferous clastics, superficial deposits, ancient crystallines, and volcanic rocks), and names or letter-symbols to represent age and lithology. The new usage distinguished Pleistocene, Ordovician (formerly Lower Silurian) and Archaean, but modified the earlier colors for USGS geologic map-units to include orange (Neocene), yellow (Eocene), yellow-green (Cretaceous), blue-green (Jura–Trias), blue (Carboniferous), violet (Devonian), purple (Silurian), pink (Cambrian), and red (Algonkian). Its symbols for formations combined geologic age and formation name, such as St for the Silurian-age Trenton Limestone. "This plan", Powell (1890: 79) asserted, would "do the least possible violence to usage", "make the greater categories most distinctive", and "correlate the different systems of symbols . . . to make time relations clear".

The 5th IGC's venue moves to Washington, 1890

The IGC's American Permanent Committee of Organization next met during the NAS regular spring meeting in 1889. The committee convened on 19 April in Washington at the Smithsonian's US National Museum (USNM) and elected Newberry as Chairman, Gilbert as Vice Chairman, and Henry Williams as Secretary. To Newberry's dismay, the committee also added Cope, Frazer, and Hunt to raise its membership to twenty-seven. At the committee's meeting on 18 November, Newberry formed the earlier-approved three subcommittees: for the scientific program, chaired by Powell; for the longer excursions, led by Dutton; and for the local excursions, composed of the Philadelphians Lesley (Chairman), Leidy, and Frazer (Dana, 1889). At the committee's request, Williams asked the IGC Bureau to delay the 5th Congress until the Columbian Quadricentennial in 1892, but the Bureau replied on 6 December, saying that it considered the request inappropriate "in consideration of the unsettled state of the legislation of the World's Fair" planned to mark the occasion in Chicago (Frazer, 1890b: 386).

The AAAS American Committee, meeting on 26 December during the NAS sessions in New York City, added to its membership Walcott (who replaced Powell), Robert Bell (Geological Survey of Canada; vice John Dawson, resigned), and Princeton's William Scott, appointed to succeed the recently deceased Cook. Hitchcock took on the Treasurer's role after Newton Winchell (University of Minnesota, State Geologist, and Alexander's younger brother) resigned, and the committee reshuffled assignments to its stratigraphic subcommittees (Frazer, 1890a: 125). Cope's, Frazer's, and Hunt's unauthorized and improper involving of the AAAS American Committee in the 'paper war', waged by Cope and his supporters against Marsh and Powell in the *New York Herald* during 12–26 January 1890 (Shor, 1974), as part of Cope's campaign since 1885 to succeed them both at the USGS, confirmed Dana's and Newberry's fears as to their good sense and also annoyed Hall and Stevenson.

By the time Newberry convened the fourth meeting of the IGC's American Permanent Committee of Organization in the USNM on 18 April 1890, while the NAS was meeting in Washington, Leidy was indisposed. To the fifteen attending members, Lesley stated his hope that the 5th IGC would *not* be held in Philadelphia. He had decided that he could not continue to chair the local committee, and Frazer, with Leidy's proxy, remained unwilling to replace Lesley unless formally appointed by the organising committee. The organizers voted to disband the local committee for Philadelphia. Lesley then moved, with Marsh seconding, that the committee should approve shifting the venue to Washington. Next, Gilbert proposed, and Lesley seconded, a motion to ask the IGC Bureau to approve the transfer. The USGS-dominated committee passed the resolution by a vote of nine (Gilbert, Hague, Lesley, Marsh, Powell, Stevenson, Walcott, Whitfield, and Newton Winchell) to three (Cope, Frazer, and Hall), with Dutton abstaining. Cope's actions, Stevenson claimed, had caused many of those who might have decided otherwise to vote 'Aye', to avoid appearing to support Cope

or condemn Marsh and Powell. Gilbert, who secured a larger majority opinion by subsequently writing letters to the absentees, asserted that the ballot reflected the result of political machinations as much as considerations for the good of science and the meeting's success. On 24 April, Cope, Frazer, Hunt, and Leidy wrote to the IGC Bureau to complain about the organizing committee's "abuse of [the] power delegated to it" (Frazer, 1890b: 388), and Cope also objected to Powell's use of the ICG to advance his "political aspirations" (Cope and Kingsley, 1890: 462). Disregarding these complaints, the Bureau voted 33 to 3 to let the Americans finalize their own venue (Frazer, 1891: 69).

Gilbert and some of the other USGS geologists welcomed the change, but, in view of the work involved, accepted their new role as local organizers and hosts somewhat reluctantly. The IGC's American Permanent Committee of Organization, now clearly distinguished from the AAAS American Committee (Williams, 1890), met again at the Massachusetts Institute of Technology (MIT) on 13 November 1890. With the change of venue now settled, but the opening of the 5th IGC only eight months away, the organizers elected Emmons as Secretary-General to fill the place of the deceased Ashburner (see Figure 1). They also appointed Emmons, whose fluent French dated from his training in Paris and Freiberg (in Saxony), as co-Secretary and Acting Treasurer. The organizers then formed two new committees: one for local arrangements in Washington, an all-USGS group composed of Dutton, Emmons, Gilbert, Hague, Powell, and Walcott; and the other, with Stevenson (Chairman), Chamberlin, and Alexander Winchell, to nominate officers for the 5th IGC. In addition, the organizers staffed the scientific-program subcommittee by assigning Chamberlin and Dana to Powell, and added Shaler and Stevenson to Dutton's subcommittee for the longer excursions (Frazer, 1890c: 401).

Figure 1 Samuel Franklin Emmons (1841–1911), 5th IGC's Secretary-General (Library of Congress).

By request, Emmons, Henry Williams, and Assistant Secretary Cross prepared (in English and French) a "circular of information" (the first of eleven such announcements, including those for the proposed field excursions) and sent it in January 1891 to geological organisations, to individual prospective attendees, and to the editors of *The American Geologist, The American Journal of Science* (*AJS*), *Science*, and other major journals worldwide. Emmons announced the registration fee (US$2.50) "for this congress only, and [one] intended to defray the cost of printing and other necessary expenses" (Emmons, 1891a). The 5th IGC was intended, like its predecessors, to "establish among geologists and geological organizations uniform methods of geological nomenclature, classification, and cartography", facilitate "mutual comprehension of the results of geological research by different nations", and "increase our knowledge of the structure and resources of the earth" (Emmons, 1893: 9).

The IGC's Committee of Organization of the 5th IGC (its new title) convened for the sixth and last time on 21 April 1891 at the USNM, while the NAS met in Washington, to learn that Cope, Frazer, and Leidy had resigned and to hear reports from four of its five subcommittees. Powell's scientific-program subcommittee recommended three principal topics for discussion-correlation of clastic rocks by structural and paleontological data, general color schemes and other geologic conventions, and the genetic classification of Pleistocene rocks. Powell claimed that discussions of these subjects would aid the overall work of national surveys and the preparation of their geologic maps. As this was an exceedingly limited list of topics or objectives, it is hardly surprising that Clarence King, the founding Director (1879–1881) of the USGS, thought the draft program too simplistic, regretted the lack of sessions on orogenies, the Earth's age, and related subjects of continuing scientific interest, and refused to have anything further to do with organizing the 5th IGC.

Dutton did not attend the organizers' meeting in Washington to report on the activities of his subcommittee on long excursions. In May 1890, Dutton had testified in a Congressional investigation of Powell's alleged mismanagement of the Irrigation Survey (IS) established within the USGS in 1888 (Rabbitt, 1980: 154–155). In July, Major Dutton left the USGS at his own request to rejoin the Army Ordnance Corps. In June 1891, Dutton was ordered to service with the arsenal at San Antonio in Texas and he did not choose to ask his Chief for permission to attend the 5th IGC.

The local committee in Washington

Gardiner Hubbard, who had helped Powell and others to establish the National Geographic Society in 1888 and served as its President, chaired the Local Committee in Washington, aided by Walcott as Secretary and seventeen other members. Hubbard also led the local Executive Committee, which included William Dall (USGS), Emmons, Gilbert, Hague, Powell, and Walcott. Five working committees handled detailed aspects of the meeting. Hague chaired the Committee on Entertainment, which also included Cross, Iddings, Willis, and USGS chemist David Day. Hubbard also directed the Committee on Finance, aided by the USGS General Assistant Marcus Baker and Iddings. Dall led the Committee on Halls and Place of Meeting, helped by George Goode (the Assistant Secretary of the Smithsonian Institution and also in charge of the USNM) and William John McGee. Powell chaired the Committee on Printing, assisted by Thomas Mendenhall, Superintendent of the US Coast and Geodetic Survey, and Edwin Willits, Assistant Secretary of the Department of Agriculture. Gilbert (Chairman), Dutton, and Willis comprised the Committee on Short Excursions.

In the 5th IGC's (final) Committee of Organisation, Samuel Langley, the Smithsonian's Secretary, served as Honorary President. Honorary Members included the Secretaries of State, Interior, and Agriculture; Powell; Mendenhall and the heads of seven other Federal agencies; King; the President of the AAAS; various presidents and professors in academe; directors or former directors of six US State geological surveys; and four USGS geologists. The committee also comprised Newberry and the five other principal officers, and the twenty-eight other resident and non-resident members of the working committees, including the USGS geologists George Becker and Marsh—but not Cope.

The 5th IGC's Bureau

The official list for the Washington meeting's Bureau contained Honorary Presidents Dana and Hall; Past Presidents Capellini, Prestwich, and Ernst Beyrich (Berlin); President Newberry (now in poor health); thirty-one national Vice Presidents (including Le Conte, Powell, and Pumpelly for the United States) representing twenty-four countries; and Secretaries-General Emmons and Henry Williams. Branner, Cross, Carl Diener (Vienna), Fritz Frech (Breslau), Emmanuel de Margerie (Paris), and George Williams served as Secretaries, principally to record and transcribe the verbal proceedings of the scientific sessions, to be conducted in French or in the newly permitted English, and the meetings of the Council and the international commissions. Hague replaced Emmons as Treasurer.

Global politics in 1891

When the 5th IGC convened in Washington on 26 August 1891, the world was free of major conflicts, as it been during the first four IGCs. The political settlements worked out at the Congress of Berlin (June–July 1878), and the subsequent revitalized or new alliances and treaties (1881–1887) that linked the Second German Reich with the Austro-Hungarian Empire, the Italian Republic, and Imperial Russia had begun to fray during the 1880s as a result of 'stirrings' by the French, but the agreements still prevented war in Europe (Kennan, 1979).

Only an Italo-American crisis directly affected the attendance of the national delegations at the 5th IGC. In March 1891, a mob in New Orleans had lynched eleven Sicilian-Americans (three of whom were still Italian citizens) who had been accused, indicted, and acquitted or convicted of the murder of the city's Superintendent of Police during his investigation of illegal activities by gangs. Italy and the United States recalled their ambassadors and the issue remained unresolved until the USA paid an indemnity. As a result of this dispute, neither Capellini nor any of the twenty-three other Italians who registered for the 5th IGC attended the meeting.

The sixty-six European geologists who did travel to Washington for the 5th IGC doubled the total of thirty-three geologists from the Western Hemisphere who had attended one or more of the first four Congresses. But the cost of trans-Atlantic travel may have been one of several concerns, including the restricted topics for formal discussion and the somewhat confused administrative arrangements and consequent delays, that contributed to reducing European attendance at, but not registration for, the 5th IGC.

Accommodations and meeting site

The 5th IGC met in Washington from 26 August to 1 September 1891, during the Capital's usual hot and humid summer, made dangerous by a renewed outbreak of cholera. As the 51st US Congress had adjourned in March, after passing appropriations bills for fiscal year 1891–1891, and the 52nd Congress would not convene until December, the legislators' absence left the hotels in Washington with ample vacancies for the IGC's attendees. During 19–25 August, Washington had hosted national meetings of the AAAS and then the Geological Society of America (GSA), which had been founded in 1888. Geologists from Britain, Canada, Germany, Hungary, Russia, and Sweden arrived before the 5th IGC to present papers at the GSA meeting. The AAAS Council appointed Stevenson, McGee, and four other officers as delegates to the 5th IGC (Wiley, 1892: 452). It also decided to appoint members of the AAAS's Section E, and also ask the GSA, to provide liaison and assistance for upcoming international geological congresses, including the World Congress of Geologists, planned for the World Columbian Exposition in Chicago.

The Local Committee arranged reduced rates for the 5th IGC's participants at four hotels in Washington. The Albemarle Hotel, which occupied all of the west side of Vermont Street between H and I Streets, N.W., served as the 5th IGC's headquarters, as it had for the AAAS and GSA meetings, and offered one-third reductions on its daily rates of US$5 (and up) for American-plan accommodations. The Ebbitt House, at 14th and F, N.W., near the USGS national offices in the Hooe Building at 1330 F, also operated on the American-plan (at $2.50 per day, with $1 extra for a private bath). The Ellesmere, at 1408 H, offered a weekly rate of $10.50. The Arno, at 16th and I, provided European-plan rooms at $1 per day (with $1 more for a private bath), but maintained a restaurant and café in the hotel. Among other nearby hotels, the committee listed the Fredonia and the Randall. All these hotels were well served by horse-drawn streetcars (at 5 cents a ride) and hackney cabs.

Like the AAAS and the GSA, the 5th IGC also held its formal scientific sessions at the Columbian College, one block east of the Albemarle at the southeast corner of 15th and H Streets, N.W. The College also housed the meeting's Bureau of Information (open from 22 August), a telegraph office, telephones, and a temporary post office. The Hooe Building's commercial occupants also included the officially recommended money exchange.

The Opening Session

Thomas Hughes (Cambridge), representing the absent Prestwich, officially opened the 5th IGC at 2 p.m. on 26 August. He and other members of the 4th IGC's Bureau had convened at 10 a.m. that day (and did so on each work-day thereafter) to approve the proposed Bureau for the Washington meeting, confirm English as well as French as the official languages for *this* congress only, and adopt the program that Powell's subcommittee had proposed for the scientific discussions. Hughes then proceeded to the election of the Bureau.

Of the two Honorary Presidents, Dana and Hall, only Hall was able to come to Washington. Past President Edmond Hébert (Sorbonne) had died in 1890 and Beyrich stayed in Germany. Le Conte replaced President Newberry, who was too ill to travel to Washington. Only twenty-three of the thirty-one national Vice Presidents attended: Charles Barrois (France); Ernest van den Broeck (Belgium); Henry Cadell (UK); Antonio del Castillo (Mexico); Théodore Chernishev (or Tschernyschev) (Russia); Hermann Credner (Germany); Albert Gaudry (France); Gerard de Geer (Sweden); Henri Golliez (Switzerland); Hughes (UK); Joseph-Clovis Kemner (a.k.a. M. Laflamme) (Canada); Le Conte (USA); Thomas Macfarlane (Canada); Frederic Mallet (UK and India); Alexis Pavlov (Russia); Powell (USA); Pumpelly (USA); Hans Reusch (Norway); Francisco San Roman (Chile); Friedrich Schmidt (Switzerland); Grégoire Stefănescu (Hungary); Emil Tietze (Austria); and Karl von Zittel (Germany).

Other major contributors to previous IGCs and their commissions on geological cartography and geological nomenclature (1881), and some members of the initial planning group for the 5th meeting, regrettably did not attend. William Blake (Berkeley), Dawson, Gustave Dewalque (Liège), Frazer, Archibald Geikie (the British Survey's Director General), Wilhelm Hauchecorne (Berlin), Hunt, Thomas Huxley (London), Albert de Lapparent (Paris), Charles Lapworth (Birmingham), Leidy (who died on 30 August), Lesley, Columbia's Henry Osborn, Prestwich, Procter, Andrew Ramsay (the British Survey's former Director General, who was to die in December), Eugène Renevier (Lausanne), Alfred Selwyn (Director of the Canadian Survey), William Topley (senior member of the British Survey), Otto Torell (Director General of the Geological Survey of Sweden), and Alexander Winchell (who died in February 1891)—were among the absentees.

Le Conte presided over the remainder of the opening session. He reminded the attendees about the goals of the IGCs—finalizing the names for the large divisions and subdivisions of rocks and corresponding epochs, agreeing on conventional symbols and a general color scheme for geologic maps, discussing the complex geological questions about which opinions differed, and encouraging personal and fraternal exchanges among the participants. Le Conte also compared the major geologic features of Europe with those of America, including those that would be seen during the coming field excursions. Hubbard, Secretary of the Interior John Noble, and Powell then welcomed the attendees to Washington and were duly thanked for their generosity and hospitality by Hughes and Gaudry.

The scientific sessions

Chamberlin opened the session of 27 August at 11.40 a.m. by proposing a six-fold genetic classification of Pleistocene deposits, rather than one based on chronology or structure. His six suggested categories included materials that were products of: (1) the direct action of glacial ice; (2) direct ice action combined with glacial drainage (assorted drift); (3) melt waters; (4) floating glacial ice; (5)

shore ice and ice-flows independent of glaciers; and (6) the action of wind on glacial or fluvio-glacial deposits. Gaudry thought the classification inconsistent and incomplete, but Hermann Credner and de Geer approved it as being practical, and could be used until a better alternative scheme could be formulated. Hughes thought its value would depend on an accurate reading of structural, paleontological, and other characters. Then McGee introduced a supplemental, more detailed, genetic classification, and Chamberlin closed the discussion by saying that a chronological classification remained the ultimate goal of glacial studies, but it was one that glaciologists were not yet able to provide. Emmons arranged for, edited, and distributed, the corrected and printed Proceedings (in English) of this and subsequent sessions at the beginning of those sessions, followed the next day by versions in French.

The 5th IGC then devoted two sessions to the chronological correlation of clastic rocks. Powell had already arranged to give the attendees the series of bulletins that showed how USGS geologists correlated rock sequences. Gilbert began the initial session at 11.40 a.m. on 28 August by reviewing general methods of classification: six of them physical (visible continuity, lithologic similarity, similar sequence, unconformities, relations to physical events, and comparative weathering and erosion); and four of them biological (relative abundance of identical species, relative abundance of allied or representative species, Lyell's comparison of Tertiary faunas with present life, and the relation of Pleistocene faunas to climatic episodes). In the discussions that followed, von Zittel favored the utility of animals over plants, de Geer promoted the value of statistical analyses of species occurrences, and Marsh thought correlations based on the sequence of vertebrate evolution preferable to those that used invertebrates or plants. Noting the growing trend toward natural classification and viewing all biotic elements as useful, Hughes called for "a system of criteria so varied that if one or more fails others can be employed" (Emmons, 1893: 159).

Le Conte passed the gavel to Gaudry and von Zittel for the renewed discussions at 10 a.m. on 29 August. Lester Ward (USGS) made his case for the chronologic utility of fossil plants and Walcott reviewed the correlation of Cambrian rocks in North America. Hall recalled how lithologic gradations had caused difficulties for the early correlations of Paleozoic sequences in New York State, and Henry Williams urged his listeners to consider the relations of organisms to the conditions of their environments; but many of them, including Johannes Walther (Jena), needed no such encouragement (Nelson, 1985: 182–183). Frech and Barrois stressed that the differences between the Paleozoic formations of Europe and North America made detailed comparisons and correlations impossible. Van Hise and Pumpelly thought lithological similarity "a phantom" (Emmons, 1893: 174) in the little-altered Precambrian sedimentary rocks in North America (termed Algonkian and below the *Olenellus* fauna), but they divided these sequences by major unconformities in several regions into Keweenawan, Upper and Lower Huronian, and basement rocks. Echoing Hughes, Gilbert concluded that "many methods of correlation must be used" (*ibid.*: 175). Both 'Group' and 'Formation' continued to be used in these discussions as terms for intervals of geologic time. Their restriction to mappable rock units in a tripartite scheme of chronologic, chronostratigraphic, and stratigraphic units did not develop in the modern sense until the 1940s (Schenck and Muller, 1941; Berry, 1968: 7–8).

Hall directed the fourth and last scientific session (an evaluation of general color schemes and other graphic procedures), which began at 11 a.m. on 31 August. Powell displayed charts of the color scheme that the USGS had adopted in 1889 for its forthcoming *Geologic Atlas* and its other geologic maps, including McGee's ongoing revision of the McGee–Hitchcock national coverage of 1884 (Nelson, 1999: 70, 72). The chromatic circle of this color series was completed, he noted, by using the extra-prismatic colors of purple and pink. Joseph Willcox, a member of the Pennsylvania State Survey's board of commissioners, observed that Powell could have made better use of the chromatic scale by using "the nine colors most forcibly contrasted with each other"—two (rather than three) of the primary colors of red and blue, and two (not one) of those of yellow and blue (Emmons, 1893: 210). Powell replied that USGS had selected "colors most readily distinguishable from each other when printed on a map" (*ibid.*: 211). When Cadell wondered why Powell avoided the use of shades of gray and black, as used by the British Survey to denote Carboniferous deposits, Powell claimed they would increase illegibility and conflict with coals in Cretaceous deposits. Cadell then pointed out that USGS cross-hatching and stippling could be employed to distinguish between units only in color-printed maps, not in those the British Survey's maps, which were still hand-colored at that time. Powell responded by noting the increased economy of transfer chromolithography.

Hughes thought it was "very difficult to devise a scheme that will meet the demands of every one." He emphasized that all schemes must consider color permanence, ready application, and show the information distinctly. All maps should be provided with scales. Hughes, echoing Powell's views on the natural selection of usage (and the Darwinian *Zeitgeist*?), felt that "the fittest scheme must survive". No advantage, Hughes believed, would come "by forcing the reconsideration" of the IGC's well-deliberated and widely noticed "tentative scheme of coloring" or voting on "small suggested alternatives". Working out the best scheme must be left to individual map-makers but it would actually be decided by the national geological surveys. To try to avoid complete anarchy and *laissez faire*, however, Hughes "strongly advocated" appointing a single international committee "to watch the map-making of the world and report to each successive Congress"; and another committee should "report from time to time upon the development of nomenclature and classification" (*ibid.*). Meanwhile, the 5th IGC had received a copy of Renevier's report on the meeting, held at Salzburg on 3 August, of the committee supervising the preparation of the geological map of Europe. One sheet was nearly completed, another almost so, and two others were being engraved. Hauchecorne promised to present proofs of three sheets when the committee convened at Lausanne in September 1892.

King came down from his professional and social base at New York City to participate in the 5th IGC's sessions. He stayed at the home of his friend the historian Henry Adams, just around the corner from the Albemarle Hotel, while Adams, a bachelor since his wife's suicide in 1885, continued his world tour with artist John LaFarge. Many of the European geologists sought King's company there to bemoan the scientific shortcomings of the program. They also were attracted by his conversation and the fine dinners that he and Becker hosted there (and elsewhere) and also (as King told John Hay) by the sanitary facilities of Adams' water-closet—at a time when cholera continued rampant in Washington. King was back in New York by 3 September.

The Closing Session

When the attendees reassembled under Hall's direction at 11 a.m. on 1 September, they agreed to a proposal by Henry Williams and de Margerie to form an International Commission of Geological Bibliography. The IGC asked its new commission, composed of van den Broeck, Chernishev, Frech, Gilbert (President), Golliez, John Gregory (London), de Margerie (Secretary), Reusch, Gustave Steinmann (Freiburg in Breisgau), and Tietze, to compile a list of existing bibliographies, request geological societies and surveys to provide detailed catalogs of their libraries and publications relating to their territories, and study methods to achieve a combined bibliography. The commission, without Gregory but with Henry Williams assisting, held its initial meeting on 20 September, while a special train was carrying members of the western excursion to Denver. The members decided to publish their proposed bibliographical products in French, but to retain the titles of books and articles in their original languages.

When the Austro-Hungarians did not renew their earlier offer to host the 6th IGC in Vienna in 1894, the Council and the General Assembly encouraged the two delegates from Switzerland to try to arrange a meeting in their country. Golliez and Carl Schmidt (Basel) promised to ask Swiss geologists and their national Government to approve and support a meeting, one of whose themes would probably be the study of mountains (Emmons, 1893: 81–82; Franks and Trümpy, 2005: 188). Emmons then read a letter of 1 August from Alexander Karpinski (Director of the Russian Geological Committee in St Petersburg), extending, by order of Tsar Alexander III, an invitation to hold the 7th IGC in Russia in 1897 (Milanovsky, 2004). Chernishev, in the name of his national colleagues, seconded the invitation. With the unanimous approval of the attendees, Emmons sent an acceptance by cable.

Le Conte reviewed the results of the 5th IGC. He concluded, to general applause, that scientific questions could not be settled by majority vote. Gilbert noted that the sentiment declared at London, to discuss scientific questions, but abstain from voting on them, had been continued in Washington. He expressed his pleasure that the 5th IGC had abjured legislative functions in favor of promoting social relations, scientific conversation, and viewing (on this occasion) American geology. Hughes, Tietze, Hermann Credner, Pavlov, de Geer, and Gaudry responded on behalf of the European attendees. Gaudry noted that "we have not made any new regulations, and anterior congresses made many". He urged his colleagues "to guard against personality" and "always to respect the liberty of science in the greatest degree possible" (Cope, 1891: 948; Emmons, 1893: 88). Le Conte then declared the Congress closed and invited the attendees to reconvene in Switzerland in 1894.

Entertainment and exhibits

The Local Committee arranged six social events during the evenings following the scientific sessions and a seventh on 1 September, after the closing session. The GSA hosted the initial reception for the attendees in the grand ballroom of the Arlington Hotel at 9 p.m. on 26 August. Through the courtesy of the Assistant Secretary of the Navy, the US Marine Band (the 'President's Own') played a medley of national anthems and airs and a selection of works by Gounod, Meyerbeer, Rossini, Sousa, Sullivan, Wagner, and Weber. Emmons and Thomas Wilson (National Museum) and their wives held more intimate gatherings at their homes at 10 p.m. on 27 August. The Smithsonian's National Museum opened its doors to the attendees during the evening of the 28th; the Korean Ambassador and Madame Ye received the participants at 5 p.m. on Saturday the 29th, and Powell invited them to meet at the USGS at 9 p.m. on the 31st. At 3 p.m. on 1 September, the attendees and the Marine Band left the 7th Street wharf by steamer for a river and garden party down the Potomac to Marshall Hall (south across the river from Mount Vernon), where an onshore collation was served at 6 p.m. The party returned to Washington at 9.30 p.m.

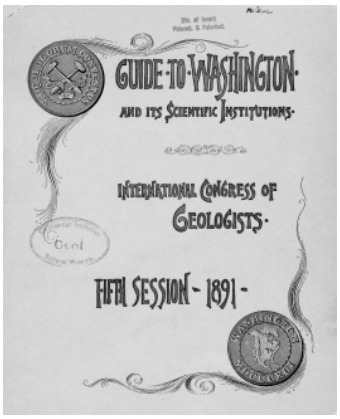

Figure 2 Cover page of the Congress's Guide to Washington (Emmons, 1891b).

Before the 5th IGC convened, participants arriving early were invited to tour paleontological collections at New Haven, Philadelphia, and Princeton. The catalog of exhibits (Emmons, 1891c) published for the meeting in Washington listed a range of serial publications, maps, photographs, fossils (belemnites, fish, and insects), and minerals. It also noted three-dimensional models, one of a Pennsylvania coal basin and the other of the experimental structures formed when Willis (1893) horizontally compressed models of beeswax 'strata' under heavy load, which were available for viewing at the Columbian College. These exhibits were provided through the courtesy of the USGS; the USNM; the Surveys of Illinois, Kentucky, Minnesota, Missouri, New Jersey, Pennsylvania, Texas, and Virginia; the national surveys of Belgium, Chile, Mexico, and Romania; the State Survey of Victoria at Melbourne; and individuals including Lesley, Friedrich Schmidt, Samuel Scudder (Boston and USGS), and Willis. Each attendee also received a copy of a *Guide to Washington and its Scientific Institutions* (Emmons, 1891b) (see Figure 2).

Field trips

The 5th IGC's organizers arranged four field excursions—one before the meeting, a second between the sessions in Washington, and two after the meeting. Less than expected registration led to the cancellation of the fourth trip, a ten-day post-Congress passage to and through the Appalachians, which was to have been led by Willis. Between 18 and 24 August, Henry Williams, aided by Charles Prosser (USGS) and Gilbert van Ingen (Poughkeepsie, New York), led an excursion to key localities in the Paleozoic of New York State. Attendees visited exposures at or near Utica, Little Falls, Trenton River, Oriskany Falls, Lake Cayuga, and Ithaca (Fall Creek and the Cornell University Museum).

From 8 a.m. to midnight on 30 August, USGS geologists Nelson Darton, McGee, George Williams, and Willis led a nearly 100-kilometer voyage by steamer along the Potomac River south of Washington. Stops at Fort Washington (east across the river from Mount Vernon), Cockspit Point, Clifton Beach, and Popes Creek gave the participants a sense of the coastal plain's strata and fossils from the Cretaceous ('Potomac' greensands), through the Eocene ('Pamunkey'), Miocene ('Chesapeake'), and Pliocene ('Lafayette'), to the Pleistocene ('Columbia'). For reference, the participants used the descriptions in *The Geology of Washington and Vicinity*, by McGee, Darton, Williams, and Willis (Emmons, 1891b), and its accompanying preliminary geologic map of the Washington (Maryland-District of Columbia–Virginia) sheet, compiled at 1:62,500 principally by Darton and George Williams in 1889–1891. The new map used thirteen units to represent Pleistocene (1), Neocene (2), Eocene (1), and Cretaceous (2) sedimentary rocks, six crystalline rock units of undetermined age identified by lithology, and 'Artificial' deposits.

On 2 September, eighty-eight geologists, other scientists, and several spouses and students left Washington by special train on the Rocky Mountain (or 'Western') Excursion—the Congress's most productive activity. The international firm of Raymond & Whitcomb provided services for the train's four Pullman Palace cars, the dining car, and the composite car at a cost of US$265 per person. This trainload of knowledge carried Frank Adams (McGill); Achilles Andreae (Heidelberg); Barrois; Alfred Bergeat (Munich); Marcellin Boule (Paris); van den Broeck; Cadell; Chamberlin; Hermann Credner; Rudolf Credner (Greifswald); Cross; Alexis Delaire (Paris); Emil von Dunikowski (Lemberg); Emmons; Joseph Eysséric (Carpentras in Provence); Mary Foster (London); Frech; Gaudry; Gilbert; Golliez; Alfred Harker (Cambridge); Hughes; Otto Jaekel (Berlin); Emanuel Kayser (Marburg); Andre Krassnov (Kharkov); Laflamme; Maximin Lohest (Liège); Hjalmar Lundböhm (Stockholm); de Margerie; Alfred Osann (Heidelberg); Pavlov; Reusch; August Rothpletz (Munich); San Ramon; Carl Schmidt; Friedrich Schmidt; Stephan Sihleano (Bucharest); Hjalmar Sjögren (Uppsala); Stef_nescu; Steinmann; August Streng (Giessen); Tietze; Felix Wahnschaffe (Berlin); Walther; Bruno Weigand (Strassburg); Israel White (University of West Virginia and USGS); George Williams; Henry Williams; Sidney von Wohrman (Munich); Ernst Wülfing (Tübingen), and von Zittel.

Each of the western excursion's participants departed from Washington with a copy of the detailed guidebook written by Cross, Eldridge, Emmons, Gilbert, 'Uly' Grant (George Williams's protégé), Hague, Iddings, McGee, Edward Orton (State Geologist of Ohio), Albert Peale (USGS), Walcott, Walter Weed (USGS), White, and George Williams, and edited by Emmons (1891d). By the end of the second day, the party had passed up the valley of the Potomac and crossed the Appalachians and four Midwest states to reach Minneapolis-St. Paul. After a six-hour stopover, hosted by Newton Winchell, the party continued west across the northern Great Plains, where the native tribes no longer posed any danger to travellers. In 1890, the US Census Bureau had officially declared (for its 11th decennial coverage) that it could no longer recognize a definite frontier in the West. The long series of campaigns against the Great Plains tribes also ended that December and in January 1891 when the Ghost Dance uprising terminated in the mutual horrors of several skirmishes between US Army units and bands of Sioux in western South Dakota (Utley, 1984: 255–257).

On 6 September, the excursionists arrived at the railhead at Cinnabar, Montana, 1,149 kilometers from Washington. They continued on by stagecoach to the Yellowstone National Park, where Hague and Iddings (who left Washington on 1 September), and Peale and Weed led their examination of Yellowstone's notable geological features (see Figure 3), before returning to Cinnabar on 13 September. Rejoining the train, the participants went west to Butte, and its Homestake Mine, and Pocatello. For an additional $15, some of them took the optional side trip to Shoshone Falls before rejoining on the 16th the main party at Salt Lake City, from whence Gilbert had guided a tour of Lake Bonneville's terraces. During 17–20 September, the travelers passed southeast across Utah Territory's Wasatch Mountains, the Tertiary watershed, and the Green River, to reach Grand Junction in western Colorado. From there, the train passed east out of the Colorado River Basin, past Rifle and Glenwood Springs, into the central Rockies and on to Aspen and Leadville, where they spent a few hours in the mines with Cross and Emmons. Passing through Canyon City, Colorado Springs, and Manitou, the party reached Denver on 20 September, where some participants took brief side-trips to see Jurassic–Tertiary sections near Morrison and Golden.

At Denver, the party divided once again. For an additional $100 each, Frech, Hughes, and the other visitors among the thirty-six participants departed on a ten-day round trip to the Grand Canyon of the Colorado. By rail, via Pueblo and Albuquerque, the group travelled 1,403 kilometers to reach Flagstaff, where they met Powell who had come west separately, in part to substitute for the absent Dutton and Walcott. Moving north by saddle horses and wagons, but without the promised tents in inclement weather, they arrived on the second day at the south rim of the Grand Canyon. There, the geologists examined the Precambrian–Permian section directly (by descending into the Canyon) and by viewing it across the Canyon from vantages like those opposite Point Sublime. On 21 September, the remaining excursioneers returned east from Denver by way of Topeka, Kansas City, and Chicago, where, on the 23rd, the main party divided for the last time. The principal group continued east to Port Huron and across Ontario to Niagara Falls, Buffalo, and Weehawken (the rail terminus). They reached New York City by ferry before noon on 26 September, having traveled 9,258 kilometers since leaving Washington.

Figure 4 Some of the Lake Superior excursionists; Pumpelly in top row, second from left (Pumpelly, 1918, v. 2, facing p. 678).

Barrois, Chernishev, Reusch, and Carl Schmidt quickly departed from Chicago on 23 September for Milwaukee, where, by invitation, they joined Pumpelly, Van Hise, and Frederick Rhinelander, Jr, in the private car of the railroad magnate Frederick Sr. The elder Rhinelander arranged for them to "be side-tracked whenever we wished to allow plenty of time for observing and discussing" geologic problems in the Lake Superior region (Pumpelly, 1918: 679). The party (see Figure 4) examined "the critical points in the geology of the upper peninsula of Michigan and its iron and copper regions, and important points in Canada" (*ibid.*). They looked at Precambrian sequences in areas in and around Iron Mountain, Republic, Ishpeming, Garden River, Sault St Marie, Michigamme, Houghton and Calumet, Keweenaw, Penokee-Gogebic, Sunday Lake, and Potato River before returning to Milwaukee on 2 October. Pumpelly also recorded their subsequent travel from Pittsfield, Massachusetts to Precambrian and Cambrian exposures (including the 'Taconic' sequences in Vermont's Green Mountains, but the 5th IGC's *Compte rendu* did not include a guide to this trip.

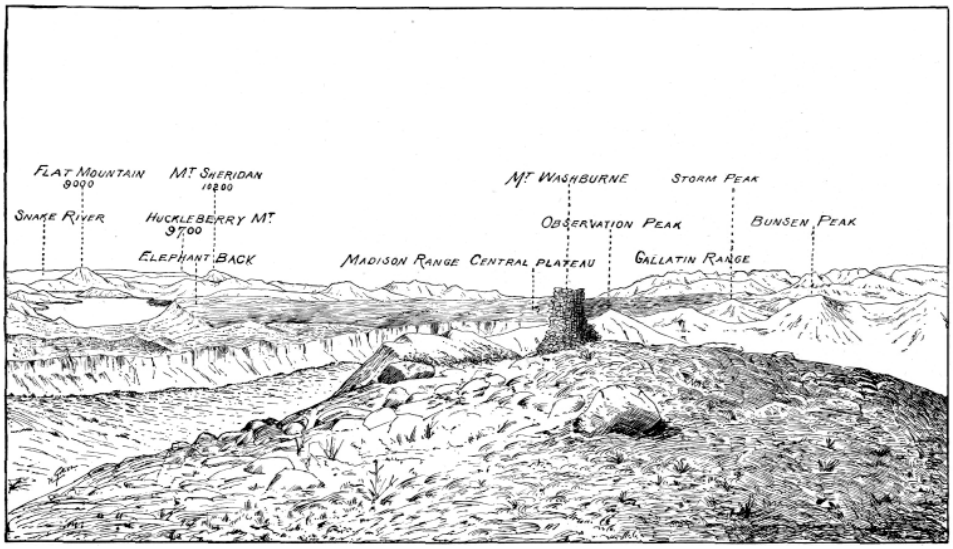

Figure 3 Panorama from Mount Washburn (3,123 meters), looking south, by Henri Golliez; Yellowstone Lake in background at left (Emmons, 1893, Plate 4).

Epilogue: The *Compte rendu*, 1893

Emmons and Cross left the western excursion at Denver on 20 September 1891 to continue their fieldwork at Leadville, Aspen, and Butte until late October. When Emmons returned to Washington, he began to compile and edit manuscripts for the 5th IGC's *CR*. He intended to publish therein a fuller account of the discussions than the brief printed summaries distributed during the sessions. Beginning in late November, Emmons sent revised copies to the geologist-discussants. He asked them to review the new versions and to write statements of their remarks to secure their opinions in their own words and languages, preserving their meanings if not their words verbatim. Emmons also requested two articles—one by Ward about paleobotanical correlation and the other by Van Hise on the Precambrian sequences in North America—to add to the volume's final proceedings and its field trip guides. Emmons continued to prepare the *CR* in 1892, as de Margerie published the longest of three interim reports, but, after 5 August, Emmons no longer did so as a USGS employee. He had been fired, along with Becker, Marsh (also NAS President), Pumpelly, and others, in Powell's agency-wide response to the financial and staff retrenchment approved by Congress and President Benjamin Harrison to encourage Powell to change his ways or resign (Rabbitt, 1980: 210–213).

Emmons agreed to continue to work without salary (which he could afford to do) if Powell would allow him to use USGS facilities to complete the editing of the *CR* and his remaining studies and those of the other members of his Colorado Division. The title page of the *CR*, published by the US Government Printing Office, bore 1893 as the year of issue, but the *AJS* did not note the volume until the following July (Williams, 1894), by which time Becker and Emmons had rejoined the USGS and Walcott had succeeded Powell as Director.

Powell could look back on both successes and failures in organizing and conducting the 5th IGC. He had shifted the meeting's site from Philadelphia to Washington, but at the cost of participation by Frazer, Hunt, and Lesley, and perhaps other geologists at home and abroad. Although attendance at the Washington meeting, the initial Congress held in the Western Hemisphere, proved less than expected, twice as many participants came from Europe than the total of those from the Americas who had traveled to the preceding Congresses; and the quality of attendees counted more than their numbers. King and some of his European colleagues criticized the scientific program (he termed it 'kindergartenish'), but its session on map colors and names continued the important discussions held at the first four Congresses (none of which King attended) and those in IGC commissions on these concerns. Observations and discussions during the 5th IGC's western excursion likely surpassed the quality of those of any session in Washington that might have been devoted to tectonics or related topics in the earth sciences.

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