

RESEARCH ARTICLE

Negotiating the norms of an international science: standardization work at the International Geological Congress, 1878–1891

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Abstract

In the second half of the nineteenth century, geologists created the International Geological Congress (IGC) to achieve the methodological and terminological uniformity that they thought their science lacked. Their desire to standardize their practice and their use of the conference to do so was neither new nor unique. Although late nineteenth-century international conferences have been recognized as important arenas of standardization, relatively little is known of the ways in which conferences organized standardization negotiations. This article aims to fill this gap by exploring how the IGC practically and socially organized standardization work. It appears that the session hall was not the sole and not even the main stage of geological standard-setting. The standardization process was also enacted through comparative study and informal exchanges that regular visits to purpose-built comparative geological exhibitions made possible. Relying on a sophisticated apparatus of commissions and sub-committees, the IGC also socially organized standards negotiation beyond the space and time of the triennial sessions. By tracing the material, spatial and social practices engineered through the IGC to serve geological standardization, this article unboxes the conference process and in so doing enriches our understanding of the period's wave of standardization.

Throughout the 1860s and 1870s, geologists from Europe and North America called to organize an international congress to address problems of standardization. For them, gathering the geological community at an international congress promised to bring about the methodological, terminological and epistemological uniformity they deemed needed for the advancement of geology. After years of hemming and hawing, the decisive push came from the United States. On 25 August 1876, the American Association for the Advancement of Science (AAAS) appointed a committee 'to consider the propriety of holding an international congress of geologists during the International Exhibition of 1878 ... for the settling of many obscure points relating to geological classification and nomenclature'.¹ This committee, later known as the Founding Committee, reached out to the Société géologique de France (SGC), which welcomed the idea and went on to organize the first session of the International Geological Congress (IGC) in the heart of the Parisian Exposition universelle in August 1878.

The geologists' desire to standardize their practice was not new. As early as the 1830s, geological associations became spaces where geologists started to collectively address

¹ Thomas Sterry Hunt, 'International geological congress', *Geological Magazine* (1876) 3, pp. 573–4, 574.

questions of heterogeneity in the use of geological symbols and nomenclature. Similarly, correlation in geological surveying started to emerge around 1850 as the growing number of national geological surveys begun to cooperate and mimic one another.² Standardization – that is, the process of constructing uniformities by means of agreed rules – was also nothing unique. The advent of capitalism, globalization and imperialism throughout the nineteenth century bolstered a frenzy of systematized standardization that took hold of pretty much everything, from building materials, scientific methods and instruments to living organisms.³

Over the past thirty years, sociologists of science have interrogated standardization in a twofold fashion. A first body of studies has characterized the resulting homogenizing effects on society and on science by showing how standardized tools, materials and organisms affect epistemology, scientific values and community building.⁴ Questioning the assumed inevitability of standardization, a second body has turned to the process of standardization itself, depicting the making of standards as a social and negotiated act. Involving actors with conflicting values and interests, standardization appears as the result rather than the cause of context-specific consensus regarding what category should be controlled, and, as such, has been shown to produce competing systems of standards.⁵ Historians of science came to study standardization from this line of inquiry and emphasized particularly the material and practical dimensions of standardization work. Analysing the standardization of physics and electrical units in the late nineteenth century, they highlighted the procedures, instruments, skills and institutions that were deployed and/or created to define, but also produce and enforce, standards beyond their immediate surroundings.⁶

In so doing, the historiography also shed light on international conferences as important sites of standardization, underscoring the interrelations as well as conflicts between different research, industrial and national traditions.⁷ Pairing standardization goals and international congresses was, one could say, a standard of the late nineteenth century as it ran through all spheres of Western industrial society.⁸ Similarly, the geologists of

² Martin Rudwick, 'International arenas of geological debate in the early nineteenth century', *Earth Sciences History* (1986) 5, pp. 152–8; Pietro Corsi, 'Introduction to thematic set of papers on geological surveys', *Earth Sciences History* (2007) 26, pp. 5–12, 6, 10; Gilles Palsky, 'Le code des couleurs dans les cartes géologiques du 19^{ème} siècle', *Comité français de cartographie* (1999) 159, pp. 63–71, 67.

³ Ken Alder, *The Measure of All Things*, New York: The Free Press, 2002; Amy Slaton, *Reinforced Concrete and the Modernization of American Building, 1900–1930*, Baltimore: Johns Hopkins University Press, 2001; Adele Clarke and Joan Fujimura (eds.), *The Right Tools for the Job: At Work in Twentieth-Century Life Sciences*, Princeton, NJ: Princeton University Press, 1992.

⁴ Lawrence Busch, *Standards: Recipes for Reality*, Cambridge, MA: The MIT Press, 2011; Nils Brunsson and Bengt Jacobsson (eds.), *A World of Standards*, Oxford: Oxford University Press, 2000.

⁵ Karen Rader, *Making Mice: Standardizing Animals for American Biomedical Research, 1900–1955*, Princeton, NJ: Princeton University Press, 2004, pp. 15–16. Stefan Timmermans and Steven Epstein, 'A world of standards but not a standard world: toward a sociology of standards and standardization', *Annual Review of Sociology*, (2010) 36, pp. 69–89.

⁶ Bruce Hunt, 'The ohm is where the art is: the British telegraph engineers and the development of electrical standards', *Osiris* (1994) 9, pp. 48–63; Simon Schaffer, 'Metrology, metrication and Victorian values', in Bernard Lightman (ed.), *Victorian Science in Context*, Chicago: The University of Chicago Press, 1997, pp. 438–74; Peter Galison, *Einstein's Clocks, Poincaré's Maps*, New York: Norton and Company, 2003.

⁷ Richard Staley, *Einstein's Generation: The Origins of the Relativity Revolution*, Chicago: The University of Chicago Press, 2008, pp. 166–203; Allen Palmer, 'Negotiation and resistance in global networks: the 1884 international meridian conference', *Mass Communication and Society* (2002) 5, pp. 7–24.

⁸ Anne Rasmussen, 'Jalons pour une histoire des congrès internationaux au XIX^{ème} siècle: régulation scientifique et propagande intellectuelle', *Relations internationales* (1990) 62, pp. 115–33; Robert Fox, *Science without Frontiers: Cosmopolitanism and National Interests in the World of Learning, 1870–1940*, Corvallis: Oregon State University Press, 2016, pp. 11–44.

this paper, scholars, industrialists and social reformers utilized the international conference to achieve consensus on common rules and methods.⁹ The importance of standardization work for conferencing was such that organizers and observers used standard-setting as a means of evaluating congress performance: for example, the Paris universal exhibitions of 1878, 1889 and 1900 determined the success of their congress programmes through the number of standard-related resolutions each congress adopted, and Belgian bibliographer Paul Otlet characterized the congress as a mode of international standardization in his 1910 typology of international organizations.¹⁰

The existing literature has thereby amply examined controversies regarding the setting of standard measures, highlighting the design of instruments and protocols to realize them and their use in different contexts. Standards negotiations have been shown to involve and intersect different scientific, commercial and public institutions, including universal exhibitions and international congresses. While the role of the congress as an arena of standardization has been well documented, the distinct way in which these conferences spatially, materially and socially organized the work of standardization remains to be understood. How did standard-setting actually work in late nineteenth-century international congresses? What were the practical forms and spaces as well as the international and social processes characterizing conference-based standardization? How did it relate to and/or build on existing arenas and practices of standardization?

In the following, I will answer these questions by examining how standardization work was enacted at the IGC. I will pay attention to the way face-to-face interactions were spatially, socially and practically organized by the IGC to serve the process of geological standardization. As Stephen Legg and others have recently shown, the conference is not merely a background to negotiation but a part of it, pointing to the defining role of the spatial, social and even atmospheric organization of the conference over the course of negotiations.¹¹ In a similar fashion, I aim to highlight the conference not just as the background to but rather as a mode of standard-setting peculiar to late nineteenth-century Europe. I will show how, by drawing inspiration in and out of geology, IGC promoters socially and practically orchestrated face-to-face standardization negotiations by including purpose-built comparative geological exhibitions and by conducting empirical work through an apparatus of specialized commissions. In this paper, I will emphasize these two particular dimensions of IGC-based standardization: first, I will discuss the introduction of comparative geological exhibitions in the congress and clarify their role in enacting the problems of unification and mediating the negotiations of standards. Second, I will emphasize the way commissions were incorporated into the long-term work of the IGC and scrutinize how the resulting apparatus of commissions socially and internationally divided the labour of unification. Finally, I will demonstrate how

⁹ Maurice Crosland, 'The congress on definitive metric standards, 1798–1799: the first international scientific conference?', *Isis* (1969) 60, pp. 226–31; Bernadette Bensaude-Vincent, 'Karlsruhe, septembre 1860: L'atome en congrès', *Relations internationales* (1990) 62, pp. 149–69; Debra Everett-Lane, 'International scientific congresses, 1878–1913: community and conflict in the pursuit of knowledge', PhD thesis, Columbia University, 2004; Nir Shafir, 'The international congress as scientific and diplomatic technology: global intellectual exchange in the international prison congress, 1860–90', *Journal of Global History* (2014) 9, pp. 72–93.

¹⁰ Charles Thirion, *Etudes sur l'organisation de grandes conférences internationales à l'Exposition universelle de 1878 à Paris*, 4 April 1877, Archives nationales, Pierrefitte-sur-Seine, France, F/12/3471, p. 9; Alfred Picard, *Exposition universelle de 1889 à Paris: Rapport général*. vol. 3, Paris: Imprimerie nationale, 1891, pp. 338–40; Paul Otlet, *L'organisation internationale et les associations internationales*, Brussels: Office central des institutions internationales, 1910, pp. 85–7.

¹¹ Stephen Legg, Mike Heffernan, Jake Hodder and Benjamin Thorpe (eds.), *Placing Internationalism: International Conferences and the Making of the Modern World*, London: Bloomsbury Publishing, 2021. Javier Ordóñez and Antonio Sanchez, 'Introduction: standards in the history of contemporary science', *Journal of History of Science and Technology* (2020) 14, pp. 1–5.

the commissions functioned to reinforce the power of larger national groups and European geological societies more generally.

The promise of face-to-face interaction

On 29 August 1878, Edmond Hébert opened the first session of the IGC at the Palais du Trocadéro in the heart of the Exposition universelle. Anticipation was high as the idea of gathering the international community of geologists had been long in the making. More than a decade had passed since Spanish Juan Vilanova y Piera voiced, at a dinner of the Société géologique de France (SGF) in 1867, what geologists came to recognize as the first public call for assembling ‘an international congress to study the best and most direct way to achieve the uniformity that everyone desires’.¹² Others followed suit, Giovanni Capellini in Italy, and, two years later, Canadian Thomas Sterry Hunt and American James Hall of the Founding Committee. Each of them anticipated that an international congress, gathering the community at large, would bring a sense of unity within its ranks. As Hébert announced in his opening speech, ‘what dominated in the motives that decided the gathering of this congress, was the need, felt by all, of a common understanding on the topic of geological classification and nomenclature’.¹³

Over the 1860–1880 period, geology underwent a process of rapid institutionalization and internationalization which encouraged geological exploration while laying bare a number of methodological and terminological problems.¹⁴ Mott Greene describes the period as the ‘great age of national geological surveys’ which powered a flurry of geological explorations throughout North America, Europe and its fast-growing colonial empires.¹⁵ This growth had two effects. First, it brought up the new generation of geologists behind the IGC’s creation, a generation of geologists like Capellini, whose work and outlook were internationalized in the service of their respective nation states.¹⁶ Second, it encouraged the systematic mapping of great stretches of the world and generated a mass of unassimilated materials on transnational geological formations. This outpouring of new research made the need for synthesis both pressing and close to impossible. The resulting chaos of terminology, missed correlations and duplications swamped geologists’ attempts to synthesize empirical evidence and eventually hindered the discipline’s development as well as the state-driven modernization projects they were funded to serve.

As a result, tackling heterogeneity was on everyone’s mind in Paris. One after the other, attendees took up the stage of the Trocadéro’s *salle des fêtes* to confirm that heterogeneous nomenclatures, classifications and cartographic methods impeded the advancement of their science. Discussing the classification of the Palaeozoic strata in America, Hall described how correlation was hampered in his country by the existence of too many ‘different nomenclatures for identical formations’. Only terminological synthesis, he claimed, could enable his colleagues to ‘give an exact notion of the nature and relations of the designated formations’ and could prepare them to undertake ‘more distant

¹² *Comptes rendus sténographiques: Congrès international de géologie tenu à Paris du 29 au 31 août et du 2 au 4 septembre 1878*, Paris: Imprimerie nationale, 1880, p. 87.

¹³ *Comptes rendus sténographiques*, op. cit. (12), p. 24.

¹⁴ Roy Porter, ‘The Industrial Revolution and the rise of the science of geology’, in Mikulas Teich and Robert Young (eds.), *Changing Perspectives in the History of Science*, Boston: Reidel Publishing, 1973, pp. 320–43; Jesús Catalá-Gorgues and Ana Carneiro, ‘Like birds of a feather: the cultural origins of Iberian geological cooperation and the European map of 1896’, *BJHS* (2013) 46, pp. 39–70, 43.

¹⁵ Mott Greene, *Geology in the Nineteenth Century: Changing Views of a Changing World*, Ithaca: Cornell University Press, 1985, pp. 193–4.

¹⁶ Marco Caciagli and Graziano Ferrari, ‘The earth sciences in the scientific letters of Giovanni Capellini’, *Annals of Geophysics* (2009) 52, pp. 667–77.

comparisons'.¹⁷ In lockstep with Hall, Swiss Eugène Renevier brought up the confusing state of map-making where 'the use of colours has been so far utterly arbitrary and individual', having for basis 'sometimes the colour of rocks, sometimes one's own fantasy'. As a result, he deplored that 'one could not see in one glimpse all the terrains of the same period'.¹⁸ Romanian Gregorio Stefanescu topped off this litany of methodological problems by complaining about the nomenclature chaos regarding the divisions of Earth's crust. Drawn to a collection of clypeasters on the fairground, Stefanescu explained that he tried to determine which terrain and stage they came from. Upon reading 'Helvetian terrain, Sahelian terrain, Cartenian terrain', he confessed to his audience, 'I was left as poorly informed as I was earlier: I did not know these new terms that were added to the Earth's crust's chronology'.¹⁹

The Parisian session also highlighted how widely shared was the hope that the face-to-face interactions permitted by the IGC could best resolve the discipline's methodological chaos. Hébert opened the IGC claiming that 'out of the exchange of ideas, of the discussion of facts and opinions, will necessarily result a salutary influence; and spontaneous reforms could be the consequences of our meetings'.²⁰ Many in attendance shared his optimism. Hall believed, as firmly as Hébert, that 'it is truly impossible that the repetition of similar meetings would not lead to greater harmony between those men working in the same field'. For him, the community 'will gauge more precisely these difficulties [i.e. diversity of standards] and will be better prepared to overcome them, by getting along personally among geologists, than by studying publications'.²¹ Others, like Renevier, pondered whether or not similar efforts ought to be reproduced through smaller, more focused special commissions. This commitment to face-to-face exchange was repeatedly asserted and celebrated over the following decade. Even when dealing with critiques of IGC procedures, Swiss Portuguese Paul Choffat did not fail to note 'how much brighter is the light thrown on a question when this question is discussed in an assembly of representatives from almost every country in the world, than when such discussion is done by means of publication which make us wait for answer for months, and more often years'.²²

This belief in the power of direct interaction may well have to do with the particular practice that was nineteenth-century geology. As Martin Rudwick pointed out, 'eyeball-to-eyeball' negotiation, as experienced in group fieldwork or in special meetings of geological societies, had become a staple of controversy resolution.²³ These collective negotiations were the occasion to test theories, confront interpretations and discuss the lack of consensus on the colouring of maps and the naming of rock formations. With the multiplication of meetings and collective excursions from the 1830s on, geologists had experienced the usefulness of regular face-to-face discussion, building up the faith of IGC attendees and organizers in the unique capacity of an international congress to bring about methodological standardization.

Outside geology, other new discursive arenas where standardization questions came to be addressed may have further strengthened the geologists' faith in the congress as well. Large scientific associations like the British Association for the Advancement of Science (BAAS) and the Royal Society in Britain had provided spaces to negotiate standards at

¹⁷ *Comptes rendus sténographiques*, op. cit. (12), p. 64.

¹⁸ *Comptes rendus sténographiques*, op. cit. (12), p. 68.

¹⁹ *Comptes rendus sténographiques*, op. cit. (12), p. 83.

²⁰ *Comptes rendus sténographiques*, op. cit. (12), pp. 25–6.

²¹ *Comptes rendus sténographiques*, op. cit. (12), p. 66.

²² Paul Choffat, 'Troisième session du congrès géologique international', in *Comunicações da Comissão dos Trabalhos Geologicos de Portugal*, vol. 1, 1883–1887, Lisbon: Typographia da Academia Real das Sciencias, 1887, pp. 211–21, 212.

²³ Rudwick, op. cit. (2), p. 157.

national and international levels. When British geologists came to discuss standards at the geological section of the BAAS, other specialized committees had been playing a critical role in pushing forward negotiation of electrical and colour vision standards.²⁴ Another of these new arenas was the universal exhibition in which geologists regularly took part as exhibitors. There they admired the careful staging of industrial progress while witnessing at the same time the problematic multiplication of competing standards and national legislations, which impeded international development and competition.²⁵ To bring order and facilitate comparability, exhibition administrators promoted standardization via complex classifications, but also by housing international congresses.²⁶ Just like the geologists with the IGC, the Parisian administrators of the 1878 Exposition universelle mobilized and theorized international congresses as tools of unification, with the aim of ‘hasten[ing] the adoption of common international rules’ that would define ‘the bases of a more advantageous harmony for all’.²⁷

Disputed visions and forms of organized co-presence

While problems of standards were extensively debated in Paris, the limited degree of organization governing discussions left attendees pondering the way unification work ought to be practically carried out at future congresses. The way the French planned the IGC in Paris was rather loose. As Debra Everett-Lane pointed out, Hébert’s committee was reluctant to restrict the congress. Instead of setting a rigid set of unification-related questions which both the exhibition organizers and the American founding committee required, the French committee circulated a list of five loosely defined topics. The list included a topic on the unification of geological nomenclature and symbols in maps and reports alongside four broad scientific issues such as new methods to delimit terrain and determine mineralogical composition.²⁸ Hébert’s committee approached the IGC as an organic endeavour, encouraging the congress to take shape through the propositions of its members and allowing them to discuss anything they chose in no particular order. The result was rather disappointing. Attendees endured a medley of unrelated communications mixing research reports with papers on nomenclature and methodology. Besides the varying relevance of papers, discussion over standardization was intermittent, vague and at times irrelevant. Session after session, attendees remained muddled in general considerations regarding what the congress ought to do.²⁹

How to do face-to-face standardization was a question that the IGC’s original promoters had grappled with for as long as they thought of creating a geological congress. The merits of face-to-face interaction were widely recognized; however, competing ideas on how it should be enacted to serve standardization work existed among promoters. Building on past experiences of congresses, committees and universal exhibitions, and responding to local needs, each defended a particular way of engineering the assembling of international geologists, the interactions they ought to have and the way the production of standards ought to be approached materially and practically in order to reach agreement.

²⁴ Simon Schaffer, ‘Late Victorian metrology and its instrumentation: a manufactory of ohms’, in Robert Bud and Susan Cozzans (eds.) *Invisible Connections: Instruments, Institutions and Science*, Bellingham: SPIE Press, 1991, pp. 23–56, 26–31; Hunt, op. cit. (6), pp. 52–60.

²⁵ Alexander Geppert, *Fleeting Cities: Imperial Expositions in Fin-de-Siècle Europe*, Houndmills: Palgrave Macmillan, 2010.

²⁶ Brigitte Schroëder-Gudehus and Anne Rasmussen, *Les fastes du progrès: Le guide des expositions universelles, 1851–1992*, Paris: Flammarion, 1992.

²⁷ Thirion, op. cit. (10), p. 8.

²⁸ Everett-Lane, op. cit. (9), pp. 55–60.

²⁹ Everett-Lane, op. cit. (9) p. 78; François Ellenberger, ‘The first international geological congress, Paris, 1878’, *Episodes* (1978) 2, pp. 20–4, 24.

Prior to the American proposal, Vilanova and Capellini had contemplated an IGC for a long time and probably drew their idea of its function and format from observing, attending and even organizing other international congresses. In August 1867, as Vilanova publicly suggested that the SGF should create the IGC, the first wave of international congresses was then in full swing.³⁰ Just as Vilanova evoked the creation of the IGC, the botanists were reconvening for a fourth session a few kilometres away where they agreed on common rules of botanical nomenclature. The geologists' awareness of other congresses and their achievements was heightened by disciplinary overlaps and concerns to see a neighbouring discipline define standards for all others.³¹

Unlike Vilanova, Capellini was a pioneering actor of the congress movement. He was an astute congress organizer who played a central role in the burgeoning international life of the earth sciences.³² He first organized the founding reunion of the International Congress of Prehistoric Anthropology and Archaeology (ICPAA) in 1865, before setting up its fifth session in Bologna in 1871. With the ICPAA, Capellini practically experienced the epistemological value of congress exhibitions. Just as with the International Congress of Botany, the ICPAA sessions had also been pairing large scientific exhibitions with its congress sessions since the mid-1860s.³³ These exhibitions were more than a stage to showcase national heritage. As Thierry Lejars demonstrated, the exhibitions Capellini organized in Bologna stimulated important scientific debates regarding Celtic presence in Southern Europe.³⁴ This experience inspired Capellini's first attempt to create an IGC three years later. In his proposal, Capellini planned to use the challenging work of correlation entailed in making the unified geological map of Italy as an opportunity to convene an IGC. As with the ICPAA exhibitions, he envisioned a hands-on approach to congressing by using the assembling of Italy's map as a vehicle for discussing and setting universal conventions on map colours and symbols.³⁵ Although his proposal failed to concretize then, we will see a similar hands-on approach at work in his preparation of the IGC's second session in 1881.

The power of on-site comparison was also central in the American proposal. For the Founding Committee, there should not have been a congress in Paris without an international geological exhibition. In their 1876 call, they argued that holding an international geological exhibition alongside the congress was essential to enable methodological and terminological standardization and in so doing to unify the discipline. They came up with this idea after visiting, with the AAAS, the vast geological collections assembled at Philadelphia's Centennial Exposition. On the fairground, Hunt explained, the small crew of European and American geologists experienced the valuable opportunity to conduct 'comparative study' of the Exposition's collections, which emulated discussions regarding issues of geological coordination and standards. As Hunt argued, the Centennial Exposition highlighted the problem that 'workers of different countries have pursued their labours to

³⁰ Claude Tapia and Jacques Taieb, 'Conférences et congrès internationaux de 1815 à 1913', *Relations internationales* (1976) 5, pp. 11–35.

³¹ In 1881, botanists opposed their 1867 code of botanical nomenclature against the IGC's proposal to define a common biological nomenclature. Everett-Lane, op. cit. (9), p. 110.

³² Francesco Gerali, 'Science and life of a geologist through his papers: the personal archive of Giovanni Capellini in La Spezia', *Earth Sciences History* (2014) 33, pp. 122–49, 129–33; Caciagli and Ferrari, op. cit. (16), pp. 668–70.

³³ Christina Oghina-Pavie, 'Botanique et horticulture dans les congrès internationaux, 1864–1868', *Bulletin d'histoire et d'épistémologie des sciences de la vie* (2012) 19, pp. 191–202; Stine Wiell 'The congress of anthropology and archaeology in Copenhagen, 1869: behind the stage', *Antiquity* (1999) 73, pp. 136–42.

³⁴ Thierry Lejars, 'Le Ve congrès international d'anthropologie et d'archéologie préhistoriques de Bologne en 1871 et l'origine controversée de l'archéologie gauloise en Italie', in Sandra Péré-Noguès (ed.) *La construction d'une archéologie européenne*, Drémil-Lafage: Editions Mergoïl, 2019, pp. 57–84, 63–4.

³⁵ Gian Battista Vai, 'Giovanni Capellini and the origin of the International Geological Congress', *Episodes* (2002) 20, pp. 248–55, 252.

a great extent independently of each other, and have given their results in such ways that it is often difficult to co-ordinate them'.³⁶

The Founding Committee proposed to explore problems of geological classification and nomenclature by taking advantage of the collections to be assembled at the 1878 Exposition universelle. The committee invited surveys, learned societies and individual geologists to send their collections to Paris in order to make 'the geological department of that exhibition as complete as possible' and issued specific guidelines on the type of collections to assemble and the way they ought to be displayed in order to enable comparative study. To facilitate inspection, 'collections should be limited to specimens of a size convenient for examination, and be accompanied with sections prepared for microscopic study'. Overall, they continued, 'these various collections should be explained as fully as possible by labels, catalogues, monographs and maps'. Importantly, these arrangements were conceived as an arena for preliminary standardization work to take place. As Hunt explained for the map section of the exhibit, the displayed material should reflect the

questions which deserve the special consideration of the Congress, such as the scales best adapted for different purposes, the colours and symbols to be used, and the proper mode of representing superficial deposits conjointly with the underlying formations. A discussion of these will prepare the way for improved general geological maps of the continents.³⁷

The different forms of IGC proposed by its promoters reflected differences in local geological problems as well as competing political and national ambitions. In Italy, the revival of geology and even Capellini's career as a geologist were closely linked to the country's unification in 1860.³⁸ Prompted by influential geologists like Capellini and Quintino Sella, the future president of IGC 1881, the new government sponsored the production of a unified geological map of Italy, funded the creation of Italy's Geological Survey in 1868 and subsidized Capellini's IGC plan in 1881.³⁹ Not only would a unified map participate in economic modernization by correlating knowledge of the country's mining resources, but its completion would also illustrate the political power of the new republican government in overcoming Italy's plaguing localism.

In America, the members of the Founding Committee faced similar challenges. The western expansion and the need to exert territorial control powered a flurry of geological surveys. The resulting dispersed structure of American geology did not just generate an impressively quick accumulation of geological knowledge.⁴⁰ It also exposed local geologists to terminological chaos, with an outpouring of new designations made strikingly conspicuous to the members of the Founding Committee by the geological exhibits of Philadelphia's Centennial Exposition. Interestingly, the hopes for international comparative study that the Americans placed in the universal exhibitions following their Philadelphia experience fell apart in Paris. Their desire to find object-based international geological displays that would underscore methodological and terminological differences clashed with the scheme of the exposition administrators, who organized displays differently to highlight national prowess and competition. Despite Hébert's effort to integrate the exposition's geological collections into the IGC, the spread-out collections failed to enable comparative study as anticipated by the Americans.

³⁶ Hunt, *op. cit.* (1), pp. 573–4.

³⁷ Hunt, *op. cit.* (1), pp. 573–4.

³⁸ Pietro Corsi, 'Much ado about nothing: the Italian geological survey, 1861–2006', *Earth Sciences History* (2007) 26, pp. 97–125, 102–11.

³⁹ Gian Battista Vai, 'The second international geological congress, Bologna, 1881', *Episodes* (2004) 27, pp. 13–20, 15–16.

⁴⁰ Greene, *op. cit.* (15), p. 258.

These local problems motivated the particular formats and agendas Capellini and the Founding Committee respectively proposed. This is particularly clear with Capellini, for whom negotiating map conventions at a congress was internationally and locally beneficial. Italy's many geological schools had repeatedly resisted the map conventions proposed by the Italian Geological Committee throughout the 1860s and 1870s.⁴¹ Calling an IGC to determine universal map conventions through the particular conundrum of the unification of Italy's geological map offered Capellini a way out. The resulting internationally defined conventions provided him with a politically neutral solution to put out local resistance, complete the geological map of Italy and fulfil the committee's political obligations.

Organizers and attendees also responded to the idea of an IGC differently. An IGC was a way to either improve, protect or promote a geological tradition as well as advance conflicting political and diplomatic agendas.⁴² From the very beginning, the IGC was an affair of state. While most attendees acted as diplomats and frequently represented their national geological surveys, nation states were heavily involved. The first five sessions were organized by leading geological nations and, except for London in 1888, all of them received governmental endorsements and substantial funding. Gian Battista Vai showed how the international geological community quickly divided regarding the IGC's purpose and methods between what he called an 'international party' and a 'national party'.⁴³ The international party pushed for international integration and conventions and included key individuals like Capellini, but also peripheral and burgeoning geological communities like the Spanish and Portuguese. As Jesús Catalá-Gorgues and Ana Carneiro indicated, the Spanish and Portuguese geological communities readily welcomed the IGC as they saw its advancement and their involvement in it as a way to accelerate local institutionalization.⁴⁴

Yet not everyone gave the IGC and its international standards project a hearty welcome. Making up the so-called national party were geology's leading nations, including Great Britain and Germany, whose geologists were rather lukewarm to the project and protective of their national traditions. At first, British geologists looked down on the IGC and perceived its standardization project as partly unnecessary for British geology.⁴⁵ For them, and as they strove to demonstrate during the fourth session that they organized in London in 1888, the IGC ought to be primarily a space for scientific discussion. In London, standardization themes and the voting of resolutions were largely removed from plenary meetings in favour of free and non-binding discussions of scientific novelty, theoretical debates and the presentation of new empirical findings. As part of Prussia's boycott of the French 1878 Exposition universelle, German geologists first stood out for their absence at the first session of the IGC. If they integrated the IGC in Bologna, their ensuing participation in standardization work was driven by a defensive attitude. In 1881, they obtained control of the international commission on the geological map of Europe and blockaded the creation of a supranational bureau to govern it, as they refused to subordinate the strategic resources of their national survey to a foreign body.⁴⁶

⁴¹ Corsi, op. cit. (38), pp. 101–3, 121.

⁴² Brigitte Schroeder-Gudehus, 'Nationalism and internationalism', in Robert Olby, Geoffrey Cantor, John Christie and Johnathon Hodge (eds.), *Companion to the History of Modern Science*, London: Routledge, 1990, pp. 909–19.

⁴³ Vai, op. cit. (39), p. 17.

⁴⁴ Catalá-Gorgues and Carneiro, op. cit. (14), pp. 40–2.

⁴⁵ David Oldroyd, 'The Archaean controversy in Britain: Part IV – some general theoretical and social issues', *Annals of Science* (1994) 51, pp. 571–92, 577–80.

⁴⁶ Philippe Bouysse, 'La genèse de la commission de la carte géologique du monde: une affaire franco-prussienne traversée par deux guerres mondiales', *Travaux du Comité français d'histoire de la géologie* (2012) 16, pp. 149–91, 155–6.

These differing attitudes towards the IGC did not just influence the nature of discussions, they also defined the form and mode of standardization that the congress adopted in and after Paris. In that regard, the 1878 session was regarded as a success. If no resolutions were taken in Paris, attendees still laid out the way standardization work and decisions were going to be done at IGC for the following decade. The Parisian assembly agreed on an agenda, which would focus on setting universal standards for nomenclature, classification and map-making. They also established the IGC as the discipline's triennial gathering and appointed two commissions, the International Commission for Geological Nomenclature and the International Commission for Geological Symbols and Colours, in order to continue standardization work between each session of the IGC. Finally, they empowered Capellini to organize the next session, for which, as we shall see, he introduced a practical model of standards negotiation that durably shaped the IGC and its successes in setting standards for the following decade.

In the following sections, I will open up what the IGC model of standardization was by dissecting how standard-setting work was organized at the IGC session and within its international commissions. I will first emphasize the practical and enacted dimensions of standardization by examining how geological exhibitions were intricately connected to in-session negotiations. I will then analyse the social nature of standards negotiation by questioning social homogeneity, regularity and inclusion in commission work.

Standardization as enacted practice

In Bologna, Capellini engineered the face-to-face interactions that the congress enabled to serve standards negotiations. Relying on his experience as congress organizer, he thoroughly constructed the programme, space and atmosphere of the Bologna session to enact the problems of standards and facilitate their collective resolution. Housing the sessions, the beautiful Lyceo Rossini and its large concert hall had been decorated with the flags and coats of arms of each participating nation to display the international character of the meeting and its constituency. Capellini also represented the problems attendees came to overcome. Under each flag, he arranged a display of maps, methodically installed to highlight both national virtuosity and the problems stemming from the confusion of colour codes and terminology governing geological map-making.⁴⁷

Furthermore, unlike Paris, Capellini fulfilled the American plan by integrating a variety of exhibition spaces in the congress. Within walking distance of the congress hall, attendees could examine the rich collections of the international geological exhibition held at the Geological Institute, study relevant materials at the Museo Civico and at the university's museums of natural history, and pursue negotiations informally at the old library of the Archiginnasio Palace. As Capellini satisfiedly noted, 'nothing had been more enjoyable and appreciated; rather often the session work of the day found valuable complements during these evening reunions' in the library's salons.⁴⁸

To ensure effective and informed exchanges on site, Capellini also tried to prepare attendees before the congress. Focus was enforced by a programme of sessions fully devoted to standard-setting work with two days on the standardization of symbols, followed by two more on nomenclature and a final day on the unification of species. Consequently, scientific communications on the state of the art were limited to a handful of evening lectures. Furthermore, Capellini's committee circulated the programme a year before the meeting and encouraged future attendees to prepare for standards discussion by adding the reports issued by the international commissions. Finally, upon arrival, more

⁴⁷ *Compte rendu de la deuxième session, Bologne, 1881*, Bologna: Imprimeri Fava et Garagnani, 1882, pp. 57–8.

⁴⁸ *Compte rendu de la deuxième session*, op. cit. (47), p. 59.

relevant material was distributed, which included publications on Italian geology and a number of maps highlighting different colouring methods such as a ‘geological map of Italy ... with the colouring model proposed by the Italian committee.’⁴⁹

Capellini’s committee also organized an award contest to encourage attendees to propose new and workable solutions to the assembly. Geologists were called to propose ‘a truly practical solution to the problem of the unification of colouring and other symbols in geological maps’ by submitting ‘a detailed essay with a sufficient number of map samples’.⁵⁰ The contest was also a way for the organizing committee to kick off standardization work once the meeting opened. The six theses that the committee received were not just ranked and awarded but introduced into the congress’s first session to feed discussion with practical models for an international scale of colours and range of conventional symbols.

Following the recommendations of the American committee, Capellini also created an international geological exhibition and made it the beating heart of the congress. Significant in size and praised by attendees for the quality of its content and arrangement, the exhibition reflected Capellini’s expertise and vision. Besides the exhibition he had organized in 1871 for the ICPAA, Capellini had been accumulating rich geological and palaeontological collections since 1858 while travelling Europe and America. Upon these collections Capellini created the Geological Museum of Bologna, which, as Vai argued, he had envisioned as a forum for comparative study and standardization work across the earth sciences.⁵¹ Just as with the Bologna museum, the IGC exhibition served negotiations by displaying what French rapporteurs Francisque Fontannes and Alexis Delaire described as ‘materials useful to consult in view of the discussions regarding nomenclature and map colouring’.⁵²

The exhibition enacted the standardization agenda of the IGC. This was particularly visible with respect to the standardization of map conventions, which, as we have seen, had particularly concerned Capellini in the past. For the map section, Capellini requested individual members and supporting organizations to send in relevant artefacts. Internationalizing the exhibit was a way for him to put on display ‘the various types of scales and colouring methods’ that were at work in geology at the time.⁵³ The display of maps was also meant to enable national delegations to showcase their respective solutions to the lack of uniformity between colouring systems. For instance, the French and the Germans sent each a map using the colour coding proposed by their respective commissions.

The exhibition of collections and maps was also meant to serve hands-on comparative study. The specimens sent to the exhibition were manipulable, examinable and, like the forty-two sections of fossils from the American delegation, even adapted for microscopic study. In the map section, the displayed maps made it possible to compare existing conventions with the new ones proposed by the international commission for graphical representation and by the different national subcommittees. Attendees could practically compare the value of different modes of representation. While the Italian committee showed side by side two identically scaled maps of Italy, one made with ‘the colour scale used by the Geological Bureau for overview maps’ and the other using ‘the colour

⁴⁹ *Compte rendu de la deuxième session*, op. cit. (47), pp. 58–9.

⁵⁰ Geologists generally used the notion of unification to designate standardization. Unification seems to have been used to highlight that uniformity of geological methodology and terminology implied the formation of a unified geological community. *Compte rendu de la deuxième session*, op. cit. (47), pp. 21–2.

⁵¹ Federico Fanti, ‘Life and ideas of Giovanni Capellini (1833–1922): a palaeontological revolution in Italy’, *Geological Society, London, Special Publications* (2010) 343, pp. 79–87, 80; Vai, op. cit. (35), p. 251.

⁵² *Compte rendu de la deuxième session*, op. cit. (47), p. 206.

⁵³ *Compte rendu de la deuxième session*, op. cit. (47), pp. 28–9.

scale proposed by the French subcommittee', the German committee did the same with two versions of the same map of Central Europe, 'one coloured with the old colours, the other with the colour scale proposed by the German committee'. They could also appreciate the actual rendering of 'the colours of the international committee' via a map of Italy printed especially for the congress in two editions, 'one with the symbol system for mountains and the other with the colour scale only'.⁵⁴ Rather than reacting and deciding on the proposed recommendations by only reading or hearing about them in reports and sessions, attendees were given the chance to see, touch and compare their actual rendering via the exhibition.

The exhibition was an integral part of the standardization programme of the congress as well. Work at the exhibition and work in session were purposefully articulated. Attendees visited the exhibition and, occasionally, other geological collections every morning before proceeding with formal discussion and deliberation in session in the afternoon. While trips to the exhibitions were generally carried out informally, Capellini still included a structured visit in which he fostered discussion by having 'the exhibitor nearby ... in order to provide his colleagues with explanations'.⁵⁵ The exhibition constituted another space of mediation where attendees explored, by other, more practical means, the complex issue of geological standardization. By enabling attendees to manipulate, observe and informally debate issues of map conventions, nomenclature and classification, Capellini's exhibition prepared the ground for formal discussion and, in the organizers' hope, facilitate agreement in the ensuing formal session.

The model Capellini put together in Bologna was widely praised and became the IGC's standard format. In their reports, attendees repeatedly emphasized how the imbrication of the exhibition into session work moved standards negotiations forward. For Renevier, by 'demonstrating how inspired the Bologna congress had been in its choice of colour', the map section of the Berlin session contributed to legitimizing past congress resolutions.⁵⁶ For German Wilhelm Hauchecorne, displaying in Berlin the maps he and the international commission for the geological map of Europe had prepared helped him mitigate critiques. Responding to British Thomas McKenny Hughes and Russian Valerian de Moellers, who claimed that the commission's colour code was unsuitable to represent the stratigraphic complexities found in Britain and Russia, Hauchecorne enjoined them to 'get closer to the map', which he used to demonstrate the adequacy of the commission's colour system.⁵⁷ Participants also noted how the exhibition sparked valuable exchanges. Renevier described, for instance, how at the exhibition of the London session 'geologists from every country regularly met ... around these concrete and discrete witnesses [i.e. the displayed collections]; and there took place [where] a number of extremely valuable comparisons and discussions. Made up of materials from recent works', he added, 'exhibitions of this kind are outstandingly evocative'.⁵⁸

Standardization as social work

The IGC was set to carry out standardization work beyond the time and space of the triennial sessions. The appointment of international commissions and national subcommittees opened new discursive and social arenas where more continuous and specialized

⁵⁴ *Compte rendu de la deuxième session*, op. cit. (47), p. 210.

⁵⁵ *Compte rendu de la deuxième session*, op. cit. (47), p. 128.

⁵⁶ Eugène Renevier, 'Résultats scientifiques du congrès géologique international de Berlin et des travaux qui s'y rattachent', *Bulletin de la Société vaudoise des sciences naturelles* (1886), 22, pp. 54–75, 57.

⁵⁷ *Compte rendu de la troisième session, Berlin, 1885*, Berlin: A.W. Schade's Buchdruckerei, 1888, pp. lxviii–lxix.

⁵⁸ Eugène Renevier, 'Congrès géologique international de Londres en septembre 1888', *Eclogae Geologicae Helvetiae* (1888) 1, pp. 227–49, 246.

negotiations were made possible. Via these spaces, the IGC promoters maintained the geological community at work. The international commissions were small, with ten to fifteen members each, and met regularly, up to five times during sessions and at least once a year between sessions. After Bologna, both commissions met in Foix in 1882 and Zurich in 1883 to carry on negotiations and prepare the ensuing session in Berlin. Meanwhile, each member state was required to appoint a national subcommittee to the IGC and its international commission. Depending on the size of the geological community these could range from a handful of men as for Spain and Portugal up to a complex organization like the British subcommittee and its dozens of specialized committees.

The international commissions played a crucial role in keeping standardization a peaceful and constructive process. The relative permanence of its membership combined with regular contacts and meetings helped the commissions to ‘iron out differences of opinion’ and, as Renevier pointed out, defuse some of the red lines that appeared in session.⁵⁹ Importantly, they were also empowered to move standards negotiations forward. This took various forms: by testing the assembly’s decisions, by resolving the questions the assembly failed to clarify and, finally, by proposing and even deciding on new resolutions. To do so, the commissions replicated the IGC’s set-up to engage in practical and experimental work. The commission of the map of Europe produced map samples to test out the readability of existing and new conventions and displayed them for examination at its yearly meetings and at the ensuing IGC session. By producing and exhibiting maps, the commission enacted problems, visualized possible solutions and, in so doing, designed unified conventions that would eventually satisfyingly accommodate the geological peculiarities of member states. As Renevier explained, the role of the commissions was to ‘realize, by its practical side ... the main goals [of the IGC]’.⁶⁰

The international commissions also contributed to reinforcing the acceptability of the standardization process and its resulting conventions by engaging with the broader geological community. Each of their yearly meetings was held as part of the annual reunion of a local geological society. In Foix, the commissions got together as part of an extraordinary reunion of the SGF, while in Zurich they were the guests of the Société helvétique des sciences naturelles. They also summoned relevant external experts. The map commission regularly invited the directors of various geological surveys to inform the discussion of specific issues. Finally, the IGC used the commissions to work out common conventions with neighbouring disciplines. The IGC mandated the nomenclature commission to collaborate with zoological and botanic societies ‘to determine laws of biological nomenclature and establish similar rules in botany and zoology’.⁶¹

The national subcommittees were another important cogwheel of the IGC’s standardization enterprise. Throughout the 1880s, the IGC could count on the regular contribution of about five to ten of the twenty registered member states, each bringing their reports and propositions in each session. Via these committees, the IGC did not just try to involve local communities in international negotiations; they also brought them to work out standardization locally. Just as with the international commissions, these subcommittees met often and provided local geologists with a space to debate standards-related questions, the IGC’s functions and ways to preserve their nomenclature and map-making conventions. The British subcommittees were exemplary. These large and industrious structures met several times a year, mostly in London, but also as part of the annual meetings of the BAAS. Via its six twenty-member committees, the subcommittee on nomenclature worked on listing names in use in the British Isles, inquiring ‘into their

⁵⁹ *Compte rendu de la troisième session*, op. cit. (57), pp. lii–liii, lxi.

⁶⁰ Renevier, op. cit. (56), p. 62.

⁶¹ *Compte rendu de la troisième session*, op. cit. (57), p. liii.

correlation with them in use in other areas', and formulated 'suggestions for the unification of the nomenclature' that would preferably protect local practices.⁶² Whether advancing or slowing down international negotiations, these subcommittees nonetheless mechanically drew their local communities into clarifying, ordering and to some extent standardizing their own ways of naming and representing geological knowledge.

The national subcommittees worked closely with the international commissions. They regularly participated in their meetings and were also mobilized in the production and testing of standards. To elaborate a functioning classification or colour convention, the international commissions could enrol the national subcommittees in a range of practical work. To produce the unified geological map of Europe, the map commission requested national committees either to sort out existing local cartographic knowledge in order to fill a gap in the correlated map of Europe or, in some cases, to produce new empirical evidence via targeted fieldwork in order to test out a proposed colour code.⁶³

In its first decade, the IGC multiplied the arenas of face-to-face interaction to engage the geological community in the task of standardization and to maintain it at work beyond its triennial meetings. Through its sessions, commissions and sub-committees, it organized standardization negotiations as a continuous, multi-level and practical task. The effectiveness of these alternate spaces for the IGC's general session stemmed in large part from organizing and repeating face-to-face interactions between members. Each arena served a particular dimension of standardization work, whether to overcome disagreement, practically produce and test out standards, or reach out and publicize the goal of standardization within and beyond the geological community. Actors acknowledged the effectiveness of regular and less formal interactions to advance the work of the IGC. As an anonymous attendee observed in Berlin, 'it is not by its formal and ostensible proceedings that the usefulness of the congress is to be measured', but by the multiple and regular spaces for informal interaction through which it enacted negotiation work.⁶⁴

A Eurocentric and exclusive club

The effectiveness of the IGC set-up in advancing geological standardization was, however, also reinforced by the Eurocentric geological community it enacted. Despite its American origins, the IGC quickly became a European affair. Between 1878 and 1900, the IGC met almost exclusively in Western Europe, with the exception of the Washington and Saint Petersburg sessions of 1891 and 1897. Accordingly, most participants originated from Western Europe, and more likely from the country hosting the session. For instance, the Berlin session recorded 255 attendees from seventeen countries, 163 of whom were German and only eleven of whom were non-European, of which nine were North American.⁶⁵ While non-Western countries were generally absent or, like India, represented by a European national, only a few nations actually managed to send sizeable delegations on a regular basis. Of the roughly twenty countries said to participate, only France, Germany, Britain, Italy, Russia, the Austro-Hungarian Empire, Switzerland and Belgium sent large delegations of about five to fifteen members to every IGC session between 1881 and 1900.

Similar imbalances ran through the IGC's standardization work, which rested in the hands of a reduced club of well-established European members. Between 1878 and 1891, and despite the already limited size of the IGC, which counted roughly four hundred

⁶² C.E. de Rance, 'The international geological congress', *Nature* (1881) 23, pp. 510–11.

⁶³ *Compte rendu des séances de la Commission internationale de nomenclature géologique et du Comité de la carte géologique de l'Europe tenues à Zurich en août 1883*, Bologna: Imprimerie Fava et Garagnani, 1883, pp. 22–3, 40.

⁶⁴ Anonymous, 'The third international geological congress', *Nature* (1885) 32, pp. 599–601, 600.

⁶⁵ *Compte rendu de la troisième session*, op. cit. (57), pp. xv–xxxv.

adherents for around 250 attendees per session, a small and rather stable club of about thirty European geologists kept control of the IGC's organization and its standardization agenda. Stemming from the IGC's largest delegations, figures such as Capellini, Hauchecorne, Hébert, Renevier and Belgian Gustave Dewalque, but also Austro-Hungarian Johan Mojsisovics, McKenny Hughes and de Moellers, were found on the bureau and the executive council of nearly every IGC meeting and actively took part in negotiations in a leading position. They could be found orchestrating negotiations as chairmen of most standards-related sessions. Some, like Capellini, Hauchecorne and Renevier, also took charge of commission business, while others, like Mojsisovics and Vilanova, showed up to almost every yearly meeting. Finally, some, like McKenny Hughes, mediated standardization work at the national level as well by acting as president or secretary of their respective national subcommittee.

The Eurocentric and cliquish nature of the IGC had important practical implications for the work of standardization. That a limited number of geologists occupied powerful positions in the IGC apparatus and piloted negotiations greatly helped the rapid production of international geological standards in the 1880s. This exclusivity enabled regular contacts and a degree of familiarity which created continuity in standardization work, sped up negotiations and, to some extent, helped level off differences of views between members. It may also explain why the commissions eventually diverged from their original mandates and started to treat the questions of nomenclature and map conventions jointly, against the assembly's decision to keep both issues separate. As the two commissions shared a number of common members and held their yearly meetings together, discussions likely crossed over. While it brought about fruitful exchanges and led to a series of decisions, it also sparked outcry at the next IGC session. Yet the IGC's Eurocentric insularity also produced hierarchies and exclusions which weakened the acceptability of the standards adopted.

Quickly, the executive bodies of the IGC took a series of decisions that made Europe into the reference space for the standardization of geology. In 1881, the decision to replace the 1878 commission on map symbols by the commission for the geological map of Europe introduced a restrictive geographical frame onto the task of unifying map conventions. This decision had two consequences. By requiring the commission to produce a unified geological map of Europe, the IGC's executive bureau de facto excluded the few non-Europeans who has so far been involved in making map conventions. The new set-up did not just make delegates like Canadian Alfred Selwyn and American Peters Lesley redundant and illegitimate participants. It also made Europe the benchmark for the making of universal geological standards. Trying to justify to his disgruntled colleagues their exclusion, American Persifor Frazer explained that it was

thought that whatever defects existed could be best observed in that portion of the world's crust which was best known to the largest number of geologists; and as to which, owing to the fact of its being split up into a large number of countries, if uniformity could be attained by mutual agreement, there was a strong probability that the system which succeeded here would be accepted by the rest of the world.

The choice of Europe was in fact a practical and even a scientific one, he claimed, 'merely an incident to (the) purpose of unification', before adding that, if the conditions 'had been as favourable as they were in Europe', 'any other part of the world might equally have been chosen as a test-area'.⁶⁶

⁶⁶ Persifor Frazer, 'Report of the sub-committee on the Archean', *American Committee Reports*, Philadelphia: American Committee, 1888, pp. A1-A50, A3-A4.

The appointment of national subcommittees also reinforced the Europeanization of the work and frame of standardization at the IGC. While it was thought to involve the geological community at large, the structure and integration of subcommittees into standards-setting work actually reduced the capacity of smaller geological nations to partake in the making of geological standards. While in 1878 geologists had proposed and debated conventions directly in session, similar interventions became rare after Bologna as the power of initiative was assigned to the international commissions and the national subcommittees. To make matters worse, the executive council decided to make the structure and method of the British subcommittees the model conditioning participation in standards negotiations. Such complex and extensive apparatus eventually excluded smaller, less organized nations from participating at all. Besides the IGC's driving forces – France, Germany, Britain, Switzerland, Belgium, Austro-Hungary and the USA – few other countries managed to set up a working subcommittee. If Romania, Portugal and Spain did submit a report to the commission of nomenclature in preparation for the Berlin session, secretary Dewalque regretted that 'several of them were extremely basic'.⁶⁷

Despite its successes, the IGC entered the 1890s facing frustration, severe critiques and growing resistance among its attendees against its Eurocentric focus, procedures and composition.⁶⁸ After years of opposition, smaller nations obtained at the London session a reform of the voting method which not only reduced its range and terms of validity but, more importantly, cancelled the deciding power that hosting nations drew from summoning sweeping delegations.⁶⁹ Already marginalized by the reform of the map commission, the Americans turned particularly defiant against the standardization enterprise of the IGC. At the Washington session they organized in 1891, they left no room for discussing the resolutions of the nomenclature commission and deliberately ignored the geological map of Europe, emphasizing instead the schemes of colour and symbols of the US geological survey.⁷⁰

The representativity, relevance and even scientific authority of the community enacted by the IGC also came into question. For American George Cook, the terms voted on at the IGC 'undoubtedly satisfied the Europeans who voted upon them', but for non-European geologists like himself 'they are too local, too geographic, too strange to have a place in any general series [and] to take in the geology of the world'.⁷¹ Similarly, many felt that the prevalence of French as the congress's lingua franca did not reflect the discipline's recent evolution and problematically empowered the IGC elite and silenced occasional attendees. As Frazer conceded, 'those most capable of throwing light on any important question are generally prevented from debating it by their inability to manage any common language with anything like equal facility'.⁷²

Conclusion

By exploring the first decade of the IGC, this paper has shown that the new space of standards negotiation opened by the rise of international conferences entailed much more

⁶⁷ *Compte rendu de la troisième session*, op. cit. (57), p. 319.

⁶⁸ For an overview of the critiques against the IGC's approach see Everett-Lane, op. cit. (9), pp. 287–92.

⁶⁹ Renevier, op. cit. (58), pp. 242–3.

⁷⁰ Emmanuel de Margerie, 'Rapport sur le congrès géologique de Washington', *Bulletin de la Société géographique* (1891) 12, pp. 506–37, 518–21; *Compte rendu de la cinquième session, Washington, 1891*, Washington: Imprimerie du gouvernement, 1893, pp. 79–80.

⁷¹ George Cook, 'On the international geological congress, and our part in it as American geologists', *Science* (1888) 290, pp. 92–3, 93.

⁷² Persifor Frazer, *The Work of the International Congress of Geologists, and of Its Committees*, Philadelphia: American Committee, 1886, p. 12.

than the mere exchange of views in formal sessions. As we have seen for geology, the work of standardization took various practical and material forms and unfolded within a sophisticated apparatus of commissions and subcommittees. The collective production and testing of colour and symbol codes in commission, the hands-on comparative study of rock samples and map conventions at the congress exhibition, and the ensuing lively informal exchanges enlivened by booze in smoky saloons were not just a part of the conference's social activities but a dimension of congress-based standardization as essential as formal session discussion. By looking beyond the congress hall and tracing the material, spatial and social practices engineered at the IGC to serve geological standardization, this article has shed light on the internal structures and culture of standardization work that were established in late nineteenth-century international conferences.

The enacted nature of standardization described in this article also highlights the often neglected yet essential role of face-to-face interactions at conferences. More than mere attendance, coming to a conference enabled participants to experience the sense of being together, in the physical company of those with whom one engaged in direct exchanges. As we have seen, the congress organizers purposefully utilized these interactions and cultivated the sense of familiarity and proximity that they generated to advance standards production. With the materialization of standardization problems via geological exhibitions, the multiplication and ritualization of standards exchanges via commissions and the social selection and stability enforced by this practical apparatus, the IGC promoters intentionally organized the face-to-face interactions that the congress implied to empower, orient and facilitate the production of geological standards.

This mode of standardization and the community it delineated stemmed from the national communities leading geology at the time and reflected both their national traditions and their interests. The nature of the international standardization of geology undertaken by the IGC rested upon this rather Eurocentric order, which, as we have seen, empowered some and excluded others. Interestingly, and despite its Eurocentric elitism, the model of standards negotiation enacted at the IGC did not only engage its direct participants. Via its international commissions and national subcommittees, particularly, it put to work a wider community of geologists that did not necessarily appear as members or attendees of the IGC but contributed nevertheless in advancing geological standardization locally and at the IGC.

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