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The Science of Eurasia: Meiji Seismology as Cultural Critique

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The term 'East Asian Science' remains common and serviceable at the turn of the millennium — it invites potential readers toward this book, for example — but increasingly as a container for objects much more vital and mobile than itself. Once an invocation of essence, it can now just as well mean science *in* East Asia, *between* sites within (or linked outside of) that geography, or even practices that *signify* East Asia, as for example, acupuncture in Europe. This re-rendered East Asia is more alive with tradition-making, the forging of hyphenated identity, and the formation of pidgins across zones of curiosity or trade. Such concepts invoke yet go beyond Joseph Needham's 'great titration'. Our instinct, moreover, need not be to untangle them as 'problems' in the manner of the scientists we study, but to learn something from our inability to fully do so.

Those of us who tell stories about 'modern' science in this region — which are stories set in colonial and post-colonial worlds — are yet in need of more flexible geo-imaginaries. 'Japanese science', for example, is a set of practices, identities, and strategies deeply moulded by locationally-induced tensions. Archipelago and nation-state are merely two corners of the space which Japanese science initially sought its place within. One might call this spatial imaginary, with reference to its Meiji-period origins, 'Eurasia'. It is not to be mistaken, however, for the physical geography that goes by the same name, although both share the virtue of having no recognizable center nor clearly-delineated periphery. Its identity lies more within an instinct to transcend, re-draw, or confound boundaries it cannot, given the contradictions of its modern birth, entirely accept nor reject. I want to tease out these characteristics of Japanese science through the story of just one problematic disciplinary manifestation: seismology, the science of earthquakes.

Contemporary scientific textbook introductions tell us that seismology was 'Western' science brought to Japan in the 19th century, in the same manner as steam engines and top hats. This makes sense to the casual lay or expert reader, because seismology is a modern, instrumental, geo-physical science, and the west-to-east trajectory of such practices is well-charted. When one looks more closely, however, the description is troubling, because there was no coherent set of theories, practices, texts, and institutions, called 'seismology' in 'The West' ready, in the middle of the 19th century, to migrate to and enlighten Meiji Japan. The formative Japanese academy of this period, even had it wanted to import people credentialed as 'seismologists', would have had a difficult time finding any. In fact it never made the effort, even though it famously scoured Europe and America for many other species of foreign scientific expert.

European scientists had been interested in earthquakes from time to time prior to the 19th century, and as Perry sailed into Tokyo Bay, Italian researchers were inventing instruments to bring them under surveillance. None of these people called themselves 'seismologists', however, as most were more interested in other, more regular (and hence more observable) phenomena of nature. The term 'seismology' was coined in the 1860s by Robert Mallet, an English civil engineer then investigating an earthquake in Naples (which remained, alas, his only one).[1] Those with a serious interest in watching the earth convulse were more likely to end up with volcanoes, which had the virtue of always being in the place one had last marked them.

It was in Japan itself, more specifically Tokyo of the 1880s, that the modern science of earthquakes — the most direct ancestor of the present discipline — actually speciated. It was Tokyo University that established the world's first chair in seismology, built the best-equipped seismology lab in the world, and graduated the first students with the word 'seismology' (*jishingaku*) on their diplomas. The 'seismograph' — the direct ancestor of the device still in use — was invented in the Meiji capitol, and the first 'seismograms' recorded there. The first seismological journal and first nation-wide series of seismological stations first appeared in Japan.[2] By 1891, the year of the Great Nobi Earthquake (after Naples, the most scientifically productive seismic event of the 19th century) Tokyo was the principle center of world seismology, a science that remained for at least another decade an amateur or tangential pursuit in the academies of Europe, and did not even exist in the United States.[3]

It is true that the 'founders' of seismology in 19th-century Japan were largely foreigners, mostly Englishmen who had been hired to teach science and engineering in the formative Japanese academy. The original seismograph, for example, was named the 'Ewing-Grey-Milne' device after its three British inventors, and was physically and theoretically embedded in a long European instrumental tradition. To stop there, however, as most textbook-writers do, is to ignore the crucial matter of context. None of Japan's proto-seismologists arrived in Tokyo with prior documented interest in earthquakes. The three inventors of the seismograph were hired as lecturers in, respectively, physics, telegraphy, and geology, and turned their attention to seismometry — as they named the fashioning of earthquake-recording instruments — as an extracurricular, and inter-disciplinary pursuit. Ewing and Grey abandoned earthquakes for other interests when their contracts expired and they returned home to Britain. The 'birth' (and as importantly, the rearing) of seismology, like that of most science projects, was thus highly location- and time-dependant.[4]

The Seismograph in the Japanese Landscape

Before the emergence of 'Anglo-Japanese' seismology, the standard European method of investigating earthquakes was to survey damage to buildings, which was called 'observational seismology' by its leading practitioner Robert Mallet. Only by mapping ruins over a large area — seeing how and in what direction walls and chimneys fell — had Europeans constructed maps of an earthquake's relative strength and direction of movement. These had been the methods by which Mallet famously 'recorded' the Great Neopolitan Earthquake of 1857. Ruins, and ruins almost alone, had allowed Mallet to locate and map an 'epicenter' and surround it with concentric 'iso-seismal' lines.[5]

The trouble for geologist John Milne, eager to record an 1880 Japanese earthquake in a way that would allow it to be compared with Mallet's data from Naples, was that Japanese buildings lacked the necessary display of damage.

> Everywhere the houses are built of wood and generally speaking are so flexible that although at the time of a shock they swing violently from side to side in a manner which would result in utter destruction to a house of brick or stone, when the shock is over, by the stiffness of their joints, they return to their original position, and leave no trace which gives us any definite information about the nature of the movement which has taken place.[6]

Mallet, whose views on earthquake movement Milne had resolved to dispute, had been able to gather data like an archaeologist — a familiar role for Englishmen in southern Europe. As he described the "meizoseismal area" (the epicentral zone) of an Italian earthquake,

> The eye is bewildered by 'a city become a heap'. [The seismologist] wanders over masses of dislocated stone and mortar … Houses seem to have been precipitated to the ground in every direction of azimuth.[7]

Earthquakes were to be 'seen' by sorting all this wreckage into patterns, and the location and depths of 'epicenters' were to be mathematically calculated from the angles of wall-cracks. For Milne, it was exceedingly difficult to measure, trace, map, 'see' the earthquake of February 1880. Because it had not sufficiently inscribed itself into the Japanese cultural landscape, it could not be fixed on the natural one.

It was this very problem of insubstantiality, however, that propelled Japanese seismology in the direction of instrumentation and Milne toward membership in the Royal Society. The lack of traces in the post-earthquake landscape of Japan meant that Anglo-Japanese seismologists devoted inordinate attention, by European standards, to inventing and using inscripting devices. "At this time", wrote Milne, "Tokyo was in reality a city of many inventions ... their name was legion."[8] At the first meeting of the Seismological Society of Japan, Milne remarked "we shall see around us a mighty forest of pendulums, springs, and delicately balanced columns". It was at the same meeting that James Ewing, professor of Mechanical Engineering and Physics at what would soon be Tokyo University, unveiled his 'seismograph' — the kernel of the later Ewing-Grey-Milne device — essentially a seismometer attached to a disc of smoked glass (and later a continuous roll of smoked paper) on which various earthquake features could be recorded.[9] The seismograph became the instrument around which the new science of seismology was built, yielding as it did a product (a 'seismogram') that was not only highly readable, but, like a telegram, vendible (between Tokyo and Europe) and reproducible in scientific reports and papers.[10]

The seismograph, later so useful everywhere, was thus at the beginning peculiarly useful in Japan. Moreover, as soon as its pendulums and tracers were properly balanced, it began to inscribe (onto paper) earthquakes that had hardly been felt, a kind that had never been important to European scientists before. Through the medium of this one instrument, Japan went from being a place where earthquakes could be felt but not traced (thus confounding European methodologies) to a site where they could be traced even if not felt. Trans-Eurasian traffic in recordable earthquakes was now set to become a Japanese specialty.

Defining 'Japan's Earthquake Problem'

Instrumental seismology began to find a home in the Imperial university and various government agencies beginning in the mid-1880s. The government had become convinced that what Milne was doing after hours was promising enough to warrant their sustained institutional support. And what was, from the standpoint of the Japanese academy, seismology's promise? Partly it was the awareness that the 'science of earthquakes', not yet fully formed in the West, was a scientific niche that Japan might readily fill and dominate. It was the recognition of *novelty*, rather than the instinct to emulate or copy, that helped give the study of earthquakes resources in Japan that it would never enjoy to the same extent elsewhere; that convinced Japan to train young people in a 'Western' discipline in which they would not (for a while longer at least) have young Western colleagues.

Sekiya Seikei and Omori Fusakichi, the first seismologists to emerge from the Japanese academy (both graduated in the 1880s), would build on the relationship with European science begun by their foreign mentors. Omori in particular would go on to make a foreign reputation that equalled or perhaps surpassed that of his teachers.[11] The Japanese scientists would have the luxury, however, at least at the beginning, of not having to mold their discipline too closely to Western scripts. They would cultivate within and around seismology a set of attitudes, stances, and arguments, political and time-dependent, which provided Japanese seismology a certain nativist identity.

The Meiji government patronized seismology not only because of its international promise, but because it offered to both define and ultimately solve 'Japan's earthquake problem'. This problem, as seen from turn of the century Japan, had a specific and intimate relation to the modernizing, westernizing project itself. As Education Minister Dairoku Kikuchi put it in 1904:

> ... on the practical side [of seismology] were considerations of houses built in foreign styles, arches, bridges, chimneys, etc., new to Japan; these were constructed without proper attention to the probable effects of the earthquake shocks peculiar to this country.[12]

During the Great Nobi Earthquake of 1891, large 'Western-style' railroad bridges, factories, and post-offices had, to the surprise of their engineers and the government alike, readily collapsed. On the other hand, certain Tokugawa-period structures like Nagoya Castle had ridden out the waves. Thus was the new foreign-derived infrastructure, which was largely the materiality of the new Japanese state itself, shown to be unexpectedly fragile before Japanese nature. This assignment of failure and success to 'foreign' and 'Japanese' buildings was of course mediated by more than 'nature'. Indeed there was a long and heated debate over the proper lessons and meaning of the Nobi earthquake, a story with too many intricacies and twists to present here. Suffice it to say that in the aftermath of the Nobi earthquake, Japanese seismology emerged not as a simple complement to other imported forms of knowledge, but as the site of a uniquely critical stance toward elements of the new foreign learning — 'facts' about nature which had, quite literally, let Japan down. Seismology in this context was both contrarian and corrective. It actively doubted, and not without reason, the ability of contemporary Western knowledge to explain and anticipate the behavior of its own objects on the Japanese earth.[13]

Seismologists — both the original foreign teachers and the Japanese they trained or mentored — began as early as the 1870s to discover 'aseismic adaptations' in 'traditional' Japanese architecture. They focused in particular on five-storey pagoda (*gojunoto*), which famously did not fall during earthquakes that easily toppled factory chimneys. The central mast of pagoda, it was claimed, were actually hanging pendula, which kept the center of gravity within the base in the same way that smaller pendula did within seismographs. Thus were ancient Japanese cultural objects and new geo-physical instruments made to quite literally converge. The pyramidal shape of Japanese castles, the joint structure of temples and shrines, and the concave stone walls of palace moats were also read by seismologists as evidence that Japanese, from a relatively ancient age, had been close students of seismic forces. Seismology was thus a 'natural' science for Japan not only because earthquakes were so common there, but because knowledge of seismic forces had a long, perhaps unique, Japanese history. Seismologists devoted a portion of their research work to historic buildings; Omori literally hooked up seismographs to pagoda, demonstrating their shared physics in his longest English-language article.[14]

This convergence between modern geo-physics and traditional carpentry was not accidental, incidental, nor casually drawn. Indeed it was bound up with seismology's uniquely strong emergence within the Meiji academy in a period of *kokusui hozon*, or "preservation of the national excellencies", the first cultural reaction against the uncritical absorption of foreign models. Seismology's instinct to tie itself closely to the Japanese landscape was also at least partly a function of its lack of close ties to a distant European one. But this 'Japanese' identity of Japanese seismology had a positive role to play as well in the arena of international science. Demonstrating even a folk understanding of seismic waves over historical time helped create deep context for modern earthquake science in Japan, adding additional, countervailing, tropes to the story of seismology's origin as a local 'Western' science founded by expatriates.

European Lines and Japanese Maps: The Omori Scale

Omori Fusakichi's published research — much of it written in English for a European scientific audience — often defines 'Japan' in the course of defining nature. Among all the seismograms, iso-seismal maps, graphs of foreshocks and aftershocks — the regular currency of a growing Eurasian seismological trade — which Omori Fusakichi tucked into the English-language *Proceedings* and *Bulletin* of the Imperial Earthquake Investigation Committee, there are numerous demonstrations of Japan's historic ability to contain destructive earthquakes, and the West's historic and ongoing difficulty at controlling the same.

Following the Great Neopolitan Earthquake of 1857, Europeans began mapping earthquakes as a series of isometric ('iso-seismal') lines, indicating degrees of intensity ('acceleration') at various distances from the epicenter. Even after the seismograph became the micro-graphic record of an earthquake, the iso-seismal map remained its macro-graphic one. In 1883 Swiss and Italian researchers had developed the Rossi-Forel Scale of Earthquake Intensity in the first effort to standardize the placement of these lines, the standard being the human and physical geography of Europe. For example, "8" on the Rossi-Forel Scale marked the area where chimneys fell and walls cracked. The zone just beyond, where the walls did not crack but plaster fell, was marked "7". Each gradation was also defined by non-physical markers. Within a magnitude 7 zone, for example, the population experienced "general panic" and church bells rang. In the zone marked "6", even further from the epicenter, there was a "general awakening of those asleep, general ringing of bells, oscillation of chandeliers, stopping of clocks", and other traces, but no falling plaster or panic. And so on.[15]

Needing to draw iso-seismal lines for Japanese earthquakes, Omori found the Rossi-Forel Scale nearly useless, given Japan's paucity of church bells, chandeliers, chimneys, etc. Omori also calculated that the scale's maximum level of intensity (expressed as the inner-most line, marked "10") marked an acceleration rate of 2,500 mm m/s 2. After that degree of ground movement the Rossi-Forel Scale simply ceased, because it presumed devastation of the built environment would be total; there would be no further markers of seismic acceleration for a seismologist to read as he approached the epicenter. But as Milne had anticipated, and Omori would confirm, the built landscape of Japan, continued to survive and sustain measurable degrees of damage after this "maximum acceleration" had been reached. Japanese seismology thus had to come up with additional categories, and key all of them to a new series of 'Japanese' markers, in what became known as the "Omori Scale".[16]

The Omori Scale maps the Japanese landscape as a collection of foreign and domestic objects with strikingly different performances. When an earthquake reaches 2,000 mm m/s 2, according to Omori's scale, "the majority of the ordinary brick [European-style] houses are partially or totally destroyed". At the higher rate of 2,500 mm m/s 2, however, only "about 3% of the wooden [Japanese-style] houses are totally destroyed". As the acceleration reaches 4,000 mm, "great iron bridges are destroyed", but 20–50% of the Japanese houses remain standing. At the maximum acceleration — above 4,000 mm m/s 2 — all buildings are completely destroyed "except for a few wooden houses". In justifying the termination of his categories before "utter devastation" — which in European terms defined the maximum acceleration rate — Omori explained that "a few wooden houses could not be totally destroyed by an earthquake, however violent".[17]

In re-writing the Rossi-Forel Scale to Japanese specifications, Omori had written the survivability of 'Japanese' buildings and the fragility of 'foreign' ones directly into the content of seismology. Their unequal relationship was now fixed in Japanese practice as scientific fact. A "2,500 mm m/s 2 earthquake" was, by definition, one in which about 3% of the Japanese houses are destroyed. The ratio (in some cases the percentage) of destroyed 'Japanese' and 'foreign' structures was now to be the normative sign of a particular acceleration of seismic waves, the principle calculation by which seismic waves were to be seen and explained over very large areas.

It is equally telling to compare Omori's to a second Italian earthquake scale, the Mercalli, developed around the turn-of-the century as a replacement for the Rossi-Forel, and adopted by most European seismologists as the discipline internationalized in the first two decades of the 20th century. While the Omori and Rossi-Forel Scales assume a seismologist reading architectural and landscape inscriptions, Mercalli's anticipates that equal stress will be placed on oral interviews. In the Mercalli Scale, an area is to be marked "2" if the earthquake is "observed only by persons in a state of perfect quiet, especially on the upper floors of houses, or by very nervous people". In the zone marked "3", "people say 'it was scarcely felt' without any apprehension, and generally without having noticed that it was an earthquake". And so on. Even after the intensity increases to the point where physical damage becomes visible, Mercalli does not abandon human seismometers. In the area of magnitude 8 (categorized as "Ruinous") the earthquake not only "collapse[s] some houses" but is "observed with great terror".[18]

In Omori's scale, not only are there no human reactions to be collected, but there are no dead bodies to be counted. Mercalli's, after a certain point, is full of victims. Relying on physical markers, Omori's scale has a greater number of categories in the range of "serious" quakes, while Mercalli's, relying on human perception, makes its finest divisions among lesser quakes, before any physical damage occurs. Yet the two scales have this much in common: each provides the seismologist with not one, but a pair of everyday seismometers. In Mercalli's case it is Italian people and Italian buildings, both of which are presented as ubiquitous and unproblematic (normative) devices for the collection of data about nature. In Omori's, the equivalents are "wooden" (i.e. Japanese) houses and the iron and masonry infrastructure recently introduced from abroad. The difference in the choice of seismometers highlights the way in which Omori and other Japanese seismologists had come to read their own landscape: as above all a collection of 'native' and 'foreign' elements. In Japan, fundamental knowledge about natural phenomenon would come not from the resonance between two 'local' seismometers, as in Italy, but the dissonance between seismometers local and foreign.

It may have been the very importance of 'foreign' seismometers that made oral interviews seem as problematic to Omori as they seemed natural to Mercalli. Would Euro-Americans resident in Japan record the same reactions as the Japanese? If they did not, what would that mean? Would the reactions of Japanese, gathered through interviews, be accepted in the West as normative — a proper data set from which to draw iso-seismal lines? Omori's teacher Milne had generally favored the foreign over the Japanese body as an accurate or normative seismometer. That is, he had not always found what ordinary Japanese said (through translators) to be useful as data. As he wrote from the Nobi Plain:

> Attempts to find out what sensations were experienced by the people at the time of the shock are unsatisfactory. People questioned will tell trivial circumstances — how they tumbled from the top to the bottom of the stairs whilst hurrying to get out of doors — girls tell how they began to cry, etc.[19]

Japanese had obviously experienced sensations, but had not experienced seismology. They had yet to be trained to notice and record those specific sensations seismologists found useful as data.

On the occasion of a rare British earthquake (in Hereford) in 1896, the geologist Charles Davison expressed surprise that "one in every five" of those interviewed in the affected zone "gave unasked his impression of the direction of the shock". What had surprised Davison was that so many Englishmen had learned the lesson that earthquakes were waves, and knowing they were waves, had expected them to move directionally. With little 'common' knowledge about earthquakes to interfere with their science-derived knowledge about wave theory (which was becoming 'common' knowledge to educated Englishmen), and without having to worry that their roofs were about to fall in, inhabitants of Hereford had unreflectingly made themselves into seismometers. The Mercalli scale and others like it were in one sense sets of instructions to the populations of 'earthquake countries' as to what should be felt, said, and remembered.[20]

The living Japanese whom Milne had most trusted as seismographs were civil servants, and then secondarily, as when he sent out "barrages" of questionnaires to meteorological stations in order to pinpoint the best locations for instruments. When Milne left Japan in the early 1890s, his students inherited the kernal of a nation-wide monitoring system that made human reaction all but superfluous.[21] Omori was thus acculturated into a discipline which from the beginning eschewed Japanese bodies as reliable recording devices. We have seen that one of the reasons seismometry found its locus among the foreign community of Tokyo, rather than in Europe, was because the Japanese landscape lacked European-style 'inscription': the wealth of damaged buildings and toppled villages that allowed Italian earthquakes to be located, measured, and chartered by the naked eye alone. It was not just the buildings, however, but the people of Japan who were not inscribed by earthquakes in ways European scientists could easily read. This distrust in Japanese witnessing carried over from Anglo-Japanese into Japanese seismology because the "correct" witnessing procedures had been embodied in instruments and practices even before the first students were matriculated.

The result was that Japanese seismology relied less on human seismometers than the same science practised in Italy, Britain, or eventually America. In his textbook *Earthquakes* of 1907, the American geologist William H. Hobbs, describes the post-earthquake investigation this way:

> Notebook and map in hand, the student traverses the wrecked district, and while memory is still fresh, gathers, sifts, and correlates the observations made by an army of non-scientific observers.[22]

These field-interviews were to be followed up by barrages of questionnaires, on which would depend the final placement of the iso-seismal lines. Japanese seismologists also depended on local information in order to locate traces (and place their instruments) but their mapping techniques relied less on "an army of non-scientific observers" than on displays of overturned gravestones, the ratios of collapsed foreign and domestic structures, and other information literally objective to a foreign scientific audience.

Objective/instrumental seismology was thus simultaneously a set of colonizing practices and a potentially powerful commentary on the colonial project itself. As long as Omori relied solely on physical markers, questions about the reliability of Japanese witnessing would never be raised. On the other hand, Omori's particular arrangement of physical markers in iso-seismal mapping raised a host of questions about the reliabilities of European engineering knowledge. The Omori Scale of Earthquake Intensity managed to isolate a fragile foreign infrastructure within a landscape of indigenous tenacity.

The cultural politics imbedded in Omori's science is more evident when one compares it to British seismology in India, which drew different cultural and political conclusions from similar circumstances. Following the "Great Indian" or Assam earthquake of 1897 the Indian Geological Survey experienced the same problems of iso-seismal mapping. The lines it eventually drew over the 160,000 square miles "effected" by the earthquake were, according to geologist Charles Davison, "purely diagrammatic", revealing only where the lines would "probably" be "if we might suppose that local conditions were uniform". Explained Davison in his later reading of the Survey's report:

> It must be remembered that one third of the area over which the shock was sensible was one from which no observations could be obtained, while another third was inhabited by ignorant or illiterate tribes.[23]

Tribes whose houses had, nonetheless, not fallen in. In the 30,000 square miles surrounding the epicenter (⅓ the area of Great Britain), only 1,542 people died, and 600 of these in a single landslide. Within the same area, according to the Survey, "all brick and stone buildings" (the buildings of the British tribe) "were practically destroyed". It was only by locating and charting these scattered examples of shattered brickwork — essentially cataloging the damage to the colonial infrastructure — that seismic mapping was able to take place at all; that "the 30,000 square miles surrounding the epicenter" became a geographical and geo-physical entity; that the earthquake was describable as "effecting" 160,000 square miles (the area within which "nearly all brick buildings were damaged"). When Davis writes that the maps "suppose that local conditions were uniform", he means they suppose that India were not India, but Britain. They map, quite literally, where general damage and destruction would have occurred had India been constructed with European materials and methods.[24]

To Davison, areas where "no observations could be obtained" map land inhabited by "ignorant or illiterate tribes". Omori maps them, in the Japanese context, as areas of indigenous skill and stability. To Davison the work of the Indian Geological Survey is a triumph of European science amid difficult local conditions. To Omori iso-seismal lines trace out the failure of European science to come to terms with unexpected local anomalies.

Japanese Scientists in Western Ruins

After the turn of the 20th century Japan would defeat a European nation (Russia) in war, and Japanese seismology would begin mounting overseas expeditions in the manner of the European sciences. Omori and his student-assistants could be found gathering data in India, Chile, and post-catastrophic San Francisco, the last site at the invitation of American geologists just beginning to awake to seismology's value. Children stoned the Japanese scientists as they walked among the ruins, injuring Omori, and drawing an official apology from California's governor. As that incident made clear, Omori did not live in a world where a "Japanese scientist" was an unproblematic identity. The Imperial Earthquake Investigation Committee was nonetheless coming to consider the whole Asia-Pacific area as its natural research base. In 1908 it would even follow the "Earthquake Belt", a trans-Eurasian feature that Omori helped chart, name, and publicize, into Europe itself.

On December 28, 1908, the most destructive earthquake in modern European history occurred in Calabria and northern Sicily, centered near the city of Messina. Within 35 seconds, about 120,000 people died or were mortally wounded, 55,000 in Messina itself and 9–10,000 in nearby Reggio. Both cities were essentially laid flat, about 98% of their houses collapsing, killing, in the case of Messina, over 50% of the urban population.[25]

Omori was already acquainted with numbers of Italian scientists. He immediately led a Japanese research team to the earthquake zone, collaborated with Italian seismologists, and filed a "Preliminary Report" on Messina in his *Bulletin* a few months later in 1909.[26] "The enormity of the destruction in Messina" , wrote Omori, "is really beyond one's imagination." It was not rare, he stated, "that 15 or more dead bodies were found buried one upon the other in the space of a single small room at the ground floor". Because the apartment houses in Messina were four to six storeys tall and the streets narrow, "it was certainly impossible for the majority of the people to save themselves, even if they had succeeded in escaping out of doors".[27] Omori compared the horrors of Messina to the situation in Nagoya following the Nobi earthquake. The rates of acceleration (intensity) in Messina and Nagoya were roughly comparable, he wrote, the Nobi quake being, if anything, slightly stronger.

> The population of Nagoya in 1891 was 165,339, which was nearly equal to that of Messina and the vicinity, and of which only 190 were killed in the earthquake. Thus, even supposing the intensity of seismic motion in Messina (1908) to be equal to that in Nagoya (1891), the number of the persons killed in the former city was about 430 times greater than that in the latter. That is

> to say, about 998 out of 1000 of the number of the killed in Messina must be regarded, when spoken in comparison to a Japanese city, as having fallen victims to seismologically bad construction of houses.[28]

Omori had actually made this observation about lethality rates at least nine years earlier, and using data that had been available not only to him, but to every seismologist in the world, since 1891. Even in those areas most devastated by the Nobi earthquake, he noted in an article of 1900, only 4 to 5% of the population had died. Within the 80,000 destroyed houses in the earthquake zone, about 7,000 people were killed, or one for every eleven houses collapsed. "The comparatively small number of the killed", he wrote in 1900, "was doubtless due to the fact that common Japanese houses are built of wood."[29] This meshed with the claim of his colleague Sekiya Seikei, made as early as 1887, that when Japanese houses 'collapsed' they often did so only partially, sometimes allowing their inhabitants to walk from the ruins.[30]

Thus did Japanese seismology begin, in the early 20th century, to speak to its Western colleagues from post-catastrophic Western landscapes. It was Omori's science that first made comparative lethality rates a category of fact-creation, predicated as Japanese seismology was on the comparison of the native and the foreign. His arguments, made in perfect English prose and illustrated by superior multi-colored maps and diagrams, would not go unheard. Italian seismologist Alfredo Montel, in his book *Building Structures in Earthquake Countries*, published the year after the Messina quake, discussed the devastation and sought to draw lessons from the ruins. Much of what he claimed to have learned about earthquakes and aseismic structures he credited to the published research of Omori. There is, one suspects on reading Montel, a felt solidarity with Japan, another 'earthquake country', politically unified in the same decade as Italy, whose native seismologists had only recently taken control of their own landscape from the scientists of Britain.[31]

Conclusion

The common analogy of "transfer" — evoking a box being packed, shipped, and its contents assembled at the other end — does not well-describe the early history of Japanese seismology. Nor, for that matter, does it fit what happened to Western engineering, which was ultimately reformulated by Japanese scholars to account for an unstable earth, a bit of physics outside the training of British civil engineers. The typicality of these examples can only be tested by further studies from Meiji Japan and elsewhere in the colonial world. But we have taken it too much for granted, I suspect, that speciation in science is more easily modeled and explained than in language, religion, theatre, literature, art, and other more obviously 'cultural' activities; that 'Western' science ca. 1900 meant a something made in Europe and America, with the rest of the world providing the raw material called 'data'. This is not to obscure or deny the strong Eurocentricity of 19th- and early 20th-century 'international science'. Indeed, if I had continued this history a bit longer, we would see Britain and Germany seizing the initiative and control over 'international' seismology, despite the comparative quietude of the ground in both places. But the historic ability of northern Europe and America to seize and dominate agendas in modern science (as much else) need not invite us to read the first generations of non-Western scientists as distantly-placed laboratory assistants, complicit in their own colonization. Meiji-period Japanese had ambitions for their Western science beyond the desire (though this was there as well) to be considered helpful in London and Berlin.

Notes

1. Robert Mallet, *The Great Neopolitan Earthquake of 1857: The First Principles of Observational Seismology* (1862).
2. "Historical" introductions to seismology texts tend to concentrate on European origins and gloss over their discipline's late 19th-century re-organization in Japan. Italian and Swiss seismologists of the late 19th century, by contrast, often went out of their way to recognize advances made in Tokyo. See footnotes 9, 10, and 31.
3. This and later sections encapsulate arguments made at greater length in my doctoral dissertation, "Foreign Knowledge, or Art Nation/Earthquake Nation: Architecture, Seismology, The West, and Japan, 1876–1925" (Ph.D. dissertation, MIT, 1998). On the founding of seismology in the Meiji academy, see also Graeme J. N. Gooday and Morris F. Low, "Technology Transfer and Cultural Exchange:Western Scientists and Engineers Encounter Late Tokugawa and Meiji Japan" in Morris F. Low, ed., *Beyond Joseph Needham: Science, Technology, and Medicine in East and Southeast Asia* (Osiris, 2nd Series, v. 13, 1998), pp. 121–27.
4. *Ibid*. These were James Ewing, Thomas Grey, and John Milne.
5. See chapter on Mallet in Charles Davison, *Founders of Seismology* (Cambridge: Cambridge University Press, 1927), pp. 65–86.
6. John Milne, "The Earthquake in Japan of Feb. 22, 1880", *Transactions of the Seismological Society of Japan* (hereafter *TSSJ*), Part II, 1880, pp. 1–115 (quotation from page 1).
7. Quoted in Davison, p. 76.
8. Quoted in A. L. Herbert-Guster and P. A. Nott, *John Milne: Father of Modern Seismology* (Tenterden, Kent: Norbury, 1980), p. 80.

[9] Milne, "Notes on the Recent Earthquake of Yedo Plain ...", p. 35; A "seismograph" invented by the Italian earthquake researcher Luigi Palmieri (who also invented the word in 1859) was actually operating in Tokyo's meteorological observatory when Milne arrived in 1876. The seismographs invented by Ewing and Grey operated on an entirely different principle, however, and represented a new level of sensitivity. The English downgraded Palmieri's device by re-classifying it as a "seismoscope" and eventually had it replaced at the Tokyo observatory with a Ewing-Grey-Milne machine.

[10] Wrote the Swiss earthquake investigator F. A. Forel in 1887: "More had been learnt from the seismograph-tracer of the Anglo-Japanese observers in two years, than twenty centuries of European science had been able to show", Prof. F. A. Forel, *TSSJ*, v. XI, 1887, p. 165. "Seismometry", as the invention of seismic recording devices was called in Tokyo, was at least indirectly influenced by the strong local interest in telegraphy. The new seismographs and telegraphs were in effect siblings, as Thomas Gray, one of the seismograph's three 'fathers', and the one most responsible for the construction of a working prototype, was a professor of Telegraphic Engineering.

[11] As the Secretary of Japan's Imperial Earthquake Investigation Committee (hereafter IEIC) from 1897 to his death in 1923, Omori would oversee the publication of its influential foreign-language *Report* series, and, following the San Francisco earthquake of 1906, its English-language *Bulletin*. The *Bulletin* of the IEIC was the first seismological journal in the world to include a detailed report of that earthquake. Omori would author the vast majority of papers in both outlets. The English seismologist Charles Davison would pay him the posthumous complement of a chapter in his book *Founders of Seismology* [see citation 5].

[12] Kikuchi Dairoku, *Recent Seismological Investigations in Japan* (Tokyo, 1904). Kikuchi's book was a summation of the accomplishments of Japanese seismology, written in English for a foreign audience, on the eve of the founding of the International Seismological Association in Strasbourg.

[13] See my "Foreign Knowledge ..." [citation 3] for a full discussion of the Nobi earthquake debate.

[14] Omori Fusakichi, "Measurement of the Vibration of Gojunotos, or 5-story Buddhist Stupas (Pagodas)", *Bulletin of the Imperial EIC*, vol. IX, 1918–21, pp. 110–52; *ibid.*, "Note on the Form of Japanese Castle Walls", pp. 30–32.

[15] I am relying on the 1883 version of the Rossi-Forel Scale printed in Charles Davison, *A Manual of Seismology* (Cambridge, UK: Cambridge University Press, 1921).

[16] In this and the following paragraphs I am relying on Omori's own English translation of his scale in Omori Fusakichi, "Seismic Experiments on the Fracturing and Overturning of Columns", *Publications of the Imperial Earthquake Investigation Committee*, no. 4, 1900, pp. 138–41.

[17] Omori, pp. 138–41.

[18] I take these translations of the Mercalli scale from Alfredo Montel, *Building Structures in Earthquake Countries* (London: Charles Griffin & Co., 1912), pp. 9–11. Montel also publishes Omori's scale and attempts to reconcile it with Mercalli's in the form of a chart.

[19] *Japan Weekly Mail*, Nov. 7, 1891, p. 559.

[20] Charles Davison, *The Hereford Earthquake of Dec. 17, 1896* (Birmingham: Cornish Bros., 1899), p. 266.

[21] John Milne, "Suggestions for the Systematic Observation of Earthquakes", *TSSJ*, vol. IV, Jan.–June 1882, p. 110. By 1904, Japan had a network of 71 local meteorological stations equipped with seismographs, and 1,437 others equipped with lesser data-recording devices (Kikuchi, p. 9).

[22] William H. Hobbs, *Earthquakes: An Introduction to Seismic Geology* (N.Y.: D. Appleton, 1907), p. 227.

[23] Charles Davison, *Great Earthquakes* (London: Thomas Murby & Co., 1936), pp. 140–41.

[24] *Ibid.*

[25] Various casualty figures have been published for this earthquake. My figure of 120,000 comes from Wakabayashi (1986). The percentage of collapsed houses, first reported by Omori [see citation 26], was repeated by Davison in 1936 (Charles Davison, *Great Earthquakes* [London, 1936] p. 203).

[26] Omori, "Preliminary Report on the Messina-Reggio Earthquake of Dec. 28, 1908"; *Bulletin of the Imperial EIC*, v. 3, no. 1, 1909.

[27] *Ibid.*, pp. 38–39.

[28] *Ibid.*, pp. 39–40.

[29] Omori, "Notes on the Great Mino-Owari Earthquake of Oct. 28, 1891", *Publications of the EIC in Foreign Languages*, No. 4 (Tokyo: EIC, 1900), p. 13.

[30] Sekiya Seikei, "The Severe Earthquake of the 15th of Jan., 1887", *TSSJ*, vol. XI, 1887, p. 83.

[31] See Montel [citation 18].