Grove Karl Gilbert’s Photographs as Evidence in Geology: Documenting the 1906 San Francisco Earthquake. MICHELE L. ALDRICH,1 ALAN E. LEVITON,2 and KARREN ELSBERND3 (1California Academy of Sciences [24 Elm Street, Hatfield, MA 01038], E-mail: maldrich@smith.edu; 2, 3California Academy of Sciences, 875 Howard Street, San Francisco CA 94103, E-mail: aleviton@calacademy.org, keelsbernd@calacademy.org).

(SLIDE 1) Serendipity often plays a larger than expected role in most scholarly pursuits, and this paper owes its existence to serendipity. It came about as a result of our study of a collection of original prints of Grove Karl Gilbert photographs, many taken in April and May 1906 documenting the aftermath of the San Francisco earthquake and fire of 18-19 April, in the Archives of the California Academy of Sciences. At the time, we were preparing a paper to celebrate the 100th anniversary of the event, which had resulted in the near total destruction of our Academy. Thus, three questions arose (SLIDE 2), and these we will address in this presentation:

- Gilbert’s 1906 earthquake studies
- Gilbert’s education as a photographer
- Gilbert’s use of images in geological reports

Now allow your mind to imagine it is April 1906. Grove Karl Gilbert was living in Berkeley, California. He was there on assignment from the US Geological Survey to study the effects of hydraulic mining (SLIDE 3) on the San Francisco Bay and estuary, a political hot potato in California. At the time Gilbert was 62 (SLIDE 4). But Gilbert had been interested in earthquakes for a very long time, dating back to 1872 when his interest was piqued by observations he had made in the Great Basin while on the Wheeler Survey. By 1883, Gilbert wrote an article that was published in the Salt Lake City Tribune in which he clearly articulated the concept that vertical displacement along faults was responsible for mountain building in the Great Basin and in the vicinity of Salt Lake City, and he warned residents of the city that movement along the fault bordering the Wasatch Front could and would generate earthquakes, for which they should be prepared. Interestingly, up to this point, and indeed as late as April 1906, Gilbert had never experienced an earthquake himself.

Gilbert’s first very brief paper following the earthquake in San Francisco appeared on 28 April in the San Francisco Mining and Scientific Press. In it, he still emphasized mountain building through vertical uplift along faults, which caused earthquakes, and which he distinguished from volcanic activity. The relation between movement along faults and mountain building dates back to his earlier experiences with the Wheeler Survey in the Great Basin. But, as well shall see, he was quick to modify his thoughts as they relate to movement along faults.

But, returning to 18 April, at first light, Gilbert, the geologist and Gilbert the photographer, emerged to record the events of the quake. He took interest in all aspects of what had happened, the dramatic (SLIDE 5), the landscape, and damage to buildings (SLIDE 6), the latter because he reasoned it would give some indication of the ground
movement (he reasoned that transverse waves moving through unconsolidated sand and soils would cause maximum damage to buildings).

Immediately following the devastating events of the 18th, two studies were initiated, one by the U.S. Geological Survey, the second by California, which set up a commission, the State Earthquake Investigation Commission. Grove Karl Gilbert was appointed to both.

Gilbert’s first expanded contribution appeared in August 1906 in an article published in *Popular Science Monthly*. This was scarcely four months after the earthquake. In this article, Gilbert included a map (SLIDE 7) showing the trace of the San Andreas Fault, which had been mapped more than a decade earlier, in 1893, by Andrew Lawson.

Chance favors the prepared mind, and first hand observations by Gilbert in Marin County, such as the horizontal offset of the fence (SLIDE 8) were to lead him to change his mind and recognize that horizontal as well as vertical movements along faults can generate earthquakes of great magnitude as well as dislocations, both horizontal as well as vertical.

As mentioned earlier, Gilbert was much interested in damage to buildings (SLIDE 9) and what that meant with respect to ground movement.

In the USGS report, published in 1907, Gilbert wrote the 14-page introduction, provided no fewer than 11 of the 100 halftone images, and he collaborated with others on the balance of the 125-page report. Gilbert’s photos were mostly of landscape (SLIDE 10), but buildings were not neglected (SLIDE 11).

In 1908, the State’s Earthquake Commission issued its massive report. This State-sponsored, Carnegie Institution-funded document was edited by Andrew Lawson (SLIDE 12) of the University of California and is most often referred to as the “Lawson Report.” Gilbert’s seminal role was not only his investigation of the fault in Marin County, especially in the vicinity of Tomales Bay, but also his many photographs (SLIDE 13). Gilbert’s fieldwork and photography in the Bolinas-Pt. Reyes region were particularly instructive. The 58 pictures he contributed to the Lawson report reveal not only a diversity of earthquake-caused changes (SLIDE 14) but they document the complexity the fault (SLIDE 15) (SLIDE16) (SLIDE 17) (SLIDE 18) and its movement (SLIDE 19), all this in lieu of seismographs. Seismographic data were available for the 1906 event, but they were too few to permit many generalizations.

At this point, we want to ask, “What happened to Gilbert’s original photographs?” We know that the USGS Photo Library has many of them, as shown in the following table (SLIDE 20), which summarizes the Gilbert photos dating from 1870 that have been mounted on the USGS website. The list is not exhaustive by any means.
But there is also a hidden treasure trove of original Gilbert prints in the Archives of the California Academy of Sciences. These are included among the papers of Academy botanist Alice Eastwood (1860-1953).

Grove Carl Gilbert met Alice Eastwood probably at outings of the Sierra Club, of which they were both members, sometime before 1906. Whatever the case, in April or early May of 1906, thus shortly after the earthquake, the two traveled together to Tomales Bay, perhaps by horseback, which was something they were to do on subsequent travels (SLIDE 21). Again, Gilbert, the geologist-photographer was to document the changes in the landscape, as seen in this photograph (SLIDE 22) showing Alice Eastwood standing at the edge of the rift. We will return to this shortly.

Let us flash back for a moment to ask the question, “Where did Gilbert get his tutelage as a photographer?” (SLIDE 23) Gilbert, in 1870, worked for John Strong Newberry (SLIDE 24) on the Ohio Survey (SLIDE 25). It was Newberry who recommended Gilbert to Lieutenant George Wheeler, which resulted in Gilbert joining the Wheeler Survey (SLIDE 26) in 1871. On this survey, Gilbert came under the influence of survey photographer Timothy O’Sullivan (SLIDE 27) from whom he learned the basics of wet-plate photography. O’Sullivan had a mentor himself, famed Civil War photographer Matthew Brady (SLIDE 28). The earliest photo of which we know that shows Gilbert in the field is one taken by O’Sullivan sometime between 1871 and 1873 (SLIDE 29). O’Sullivan’s photographs are among the finest of its genre of the West (SLIDE 30).

In 1875, Gilbert joined the Powell Survey where he worked with John Hillers (SLIDE 31) whose dramatic use of contrast (SLIDE 32) was a lesson that would serve Gilbert well in years to come.

But times change and the technology of photography changed too: wet plate gave way to dry plate and then to film. As a result, no longer did the field geologist require a photographer to accompany him. The geologist became his own photographer. But the change did not come all at once, nor did it have an immediate impact on what appeared in publications. Thus, although by 1883 we see more Gilbert photos showing up, for example the columnar structures recorded by Gilbert in the Blue Ridge of Virginia (SLIDE 33), this and his later photos, such as 1891 photograph of Meteor Crater in Arizona (SLIDE 34), his 1895 photo of Niagara Falls, New York (SLIDE 35), and of an iceberg in Muir Inlet, Glacier Bay, Alaska in 1899 (SLIDE 36) were used to document geological details. Clearly, as time progressed, Gilbert’s photographs become increasingly useful and even dramatic. Gilbert, the geologist, and Gilbert, the photographer, had matured.

(SLIDE 37) One question often leads to another. In this case, we asked, how did Gilbert use images in his geological reports? In his classic 1877 publication on the Henry Mountains (SLIDE 38), Gilbert used drawings and engravings, the former usually based on sketches he and others had made in the field that were then redone by artists for publication, such as Waterpocket Canyon (SLIDE 39) and Mount Holmes (SLIDE 40). In
his Bonneville monograph of 1891 (SLIDE 41), Gilbert continued to use engravings, such as the panorama (SLIDE 42) by USGS artist William Holmes (SLIDE 43). Holmes had worked for both Hayden and Powell, and Gilbert put his extraordinary talents to good use. But Gilbert also included in engravings made from photographs others had taken, such as C.R. Savage’s Sheep Rock (SLIDE 44) on the Great Salt Lake.

In 1898, Gilbert joined the Harriman expedition to Alaska. His report on glaciers and glaciation (SLIDE 45) included many illustrations that were based on photos he took, such as that of the Muir Glacier (SLIDE 46). But the Harriman reports used engravings done from the original photos, such as the Muir Glacier (SLIDE 47), or heliotype prints. Gilbert used the latter to good effect, documenting changes in landscape, or rather glacierscape, over time. Thus, in his plate illustrating the Turner Glacier (SLIDE 48), he compares the glacier based on photos, one taken by him in 1899, and the other by I.C. Russell in 1891. Gilbert’s image had to be severely cropped for the comparison; the original (SLIDE 49) is by far a more comprehensive and impressive view of the glacier and surroundings. What is also important, here, for the first time to our knowledge, Gilbert uses photographs to document change over time, before and after, something he was to do in his 1908 report on the San Francisco earthquake in which he showed the effect of fault slippage on Bailey’s Pier at Inverness (see SLIDE 14).

For some reason, and we do not know why, there are no halftones in the Harriman report. Thus, Gilbert’s use of halftones depended on the publisher. Although he used halftones in several earlier memorials, his first use in geology to the best of our knowledge is to be found in the Geological Society of America’s Bulletin of 1899 (SLIDE 50).

In summary, Grove Karl Gilbert learned design and composition from both Timothy O’Sullivan and John Hillers. He used photographs for scientific documentation. He readily adapted to major changes that took place during his lifetime in photographic technology, wet plate to dry plate, to film, drawings to engravings, to heliotypes, to halftones. Gilbert took full advantage of each step having lived through all phases of this technological revolution.

And, as for the California Academy of Sciences, in 1917 Gilbert and Alice Eastwood (SLIDE 51) had decided to marry after a courtship that lasted well over a decade. In early 1918, on his way to California, Gilbert stopped off to visit his sister in Michigan. There he died, but the Gilbert legacy at the California Academy of Sciences was kept alive in the images he had left with Alice Eastwood during their years together. This legacy was lost from sight for nearly 100 years until the photographs were rediscovered by Academy staff barely one year ago.

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References


Jordan, David Starr, ed. The California Earthquake of 1906. A.M. Robertson, San Francisco, California, USA. 371 pp., illus.


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Gilbert’s 1906 Earthquake Studies

Gilbert’s Education as a Photographer

Gilbert’s Use of Images in Geology Reports
Hydraulic mining at the Esperance Mine, French Corral, California

Grove Karl Gilbert
Fire cloud over San Francisco. Photo taken from somewhere in the East Bay by G.K. Gilbert.

Damage done to buildings in Oakland. Photo by G.K. Gilbert, 18 April 1906
San Andreas Fault.
From Gilbert, *Popular Science Monthly*, August 1906

Fence offset 8.5 ft. by fault. Looking northwest. Fault, concealed by grass, crosses from left to right, touching both the disjoined ends of the fence.
School-house at Point Reyes Station, near Inverness, shifted horizontally two and one-half feet by the earthquake. Photo by G.K. Gilbert.

Fault trace two miles north of the Skinner Ranch at Olema. View is north. Illustrates ridge phase.
Gutted interior of Academy museum building after earthquake and fire. Note that steel-reinforced floors are intact.

Andrew Cowper Lawson
(Above) Pre-earthquake photo of Bailey’s Pier, Inverness. Photo by Martha P. Schreiber; published by GK Gilbert in Lawson (1908).

(Right) Post-earthquake photo of Bailey’s Pier, Inverness, by GK Gilbert. Originally straight; shifted and much broken. In subsequent repairs, curvature caused by the earthquake was retained.
Branch of trace-fault, near Bondietti’s Ranch. Looking south. Illustrates diagonal cracks in ridge phase of fault trace.

Looking southeast from point near Shafter’s Ranch, Olema. Fault-trace follows base of hill and includes water-filled depression.
Fault trace and sag ponds south of Shafter

San Francisco, California, Earthquake April 18, 1906. Secondary cracks on the shore of Bolinas Lagoon.
Buckling caused by earth flow, Howard Street, San Francisco, 18 April 1906
USGS Photo Archives, Denver

Gilbert’s Photographs on USGS Photo Archive Website

1870: Ohio
1883: Virginia (Blue Ridge)
1885: Washington, D.C. deltas and terraces
1889: New York State lake shores
1891: Meteor Crater (Arizona)
1895, 1902: Niagara Falls
1899: Harriman Expedition, mainly Alaska
1901: Wasatch fault scarps and other Bonneville features
1903: Sierra Nevada (California), including Yosemite
1905–1909: Hydraulic mining (California)
1906–1908: Earthquake (California)
Grove Karl Gilbert and Alice Eastwood in Yosemite, 1908

On the edge of rift, Marin Co.
Gilbert’s Education as a Photographer

John Strong Newberry
Smithsonian Archives
Ohio. Delta of recent formation at the edge of an artificial pool near Berea. Photo (USGS Photo Archives) attributed to GK Gilbert circa (?) 1870 but at least date is unlikely.

Wheeler Survey (undated photo) Smithsonian Archives
Darien Expedition, 1870:
Timothy O’Sullivan

Matthew Brady
after the battle of
Bull Run
(June 1861)
Gilbert in the field, 1871 or 1873
Photo by Timothy O'Sullivan

Black Cañon of the Colorado, by Timothy O'Sullivan
John Hillers on the Aquarius Plateau, Utah, in 1875 (Powell Survey). Photo by either Thompson or Gilbert.

Grand Canyon of the Colorado River at the foot of the Toroweap, Arizona; n.d. Photo by John Hillers.

Meteor Crater, Arizona. Across the crater, viewed from the south. 1891.
Niagara Falls, New York and Canada. American Falls, viewed from Goat Island. The camera was placed as nearly as possible in the position occupied by Captain Basal Hall when he made his camera lucida sketch in 1828. Photo by GK Gilbert, 1895.

Harriman expedition. Iceberg in Muir Inlet, Glacier Bay, Southeastern Alaska. 1899
Gilbert's Use of Images in Geology Reports

GK Gilbert (1877)

Geology of the Henry Mountains

Title page
Waterpocket Canyon as drawn in Gilbert’s notebook (above) and as retouched by an artist and published by Gilbert in his *Henry Mountains* monograph (1877) as Figure 68. (From Hunt 1988.)

Henry Mountains: Mount Holmes, from the north
GK Gilbert (1890)

*Lake Bonneville*

Title page

Lake Bonneville: Shore-line on the north end of the Oqurrh Range, Utah
Sheep Rock, a Sea-Cliff on the shore of Great Salt Lake. From a photograph by C.R. Savage.
Harriman Expedition: Muir Glacier (image as published in Gilbert (1904))

Harriman Expedition: Turner Glacier. Heliotype print of I.C. Russell photo taken in 1891 (above) and G.K. Gilbert’s taken in 1899 (below).
Harriman Expedition: Turner Glacier in 1899 (GK Gilbert Photograph)

Gilbert’s first use of halftones.  
*GSA Bull.* 10 (1899), Dislocation at Thirtymile Point, New York, pl. 12.
Alice Eastwood in Yosemite (1908)

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