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Earthquake prediction, biological clocks, and the cold war psy-ops: Using animals as seismic sensors in the 1970s California☆

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ABSTRACT

A familiar story of seismology is that of a small field originally focused on local studies of earthquakes through diverse disciplinary perspectives being transformed, in the second half of the twentieth century, into a highly specialized field focused on global studies of the earth's deep interior via sophisticated instruments and transnational networks of seismological stations. Against this backdrop, this essay offers a complementing account, highlighting the significance of local circumstances and disciplinary agendas that were contingent not only on transformations in the geophysical sciences but also on the concurrently changing biological sciences during the Cold War. Using examples of the studies of unusual animal behavior prior to earthquakes conducted under the auspices of the US Geological Survey on the West Coast of the United States in the 1970s, this essay examines a variety of motivations behind the attempts to bridge geophysics and biology. These examples illustrate the ways in which earthquake prediction became entangled with concerns over the use of seismological data, pioneering research on biological rhythms, and the troubled field of Cold War-driven military brain studies.

In 1976, the Office of Earthquake Research of the US Geological Survey (USGS) undertook an unusual study. The study's aim was to assess the possibility of using animals as biological sensors capable of detecting subtle changes in the geophysical environment preceding earthquakes.[1] The results were presented at two conferences sponsored by USGS in 1976 and 1979 (Evernden, 1976, 1980). In one study, the interdisciplinary team from UCLA, which included a geophysicist, an environmental scientist, and a marine biologist, monitored the behavior of California's kangaroo rats and pocket mice. The animals were trapped in the wild and observed in an experimental setup in Big Morongo Wildlife Reserve in San Bernardino County, California, located within a few kilometers of the active Banning-Mission Creek branch of the San Andreas Fault — the place where two tectonic plates meet, triggering some of California's greatest earthquakes. The "gross motor activity," as manifested by the animals' use of a running wheel or passage of an animal through a switch gate, was monitored in the system of interconnected "activity boxes," with data recorded electronically on magnetic tape and stored in a computer. The "activity data" were then compared with seismic data supplied by the USGS southern California seismic networks, "to determine whether correlations exist between changes in the pattern and intensity of the [animals'] activity and subsequent seismic events" (Evernden, 1980, p. 200).

In another study, the research team from UC Davis, which included a zoologist, a geologist, and a physiologist, interviewed farmers living close to the epicenters of past earthquakes, and entertained further possibilities of "utilizing some quantifiable measure" of the behavior of the animals living in the controlled environment of a farm. One such proposal is worth quoting at some length:

> "Two such measures [of abnormal behavior prior to earthquake] suggest themselves: egg production and milk production. … In order to obtain useful data, it is probably necessary to monitor the daily production of individual cattle. This can be done through the use of a flow meter placed in the milking line. We envisage a monitoring system in which ten cows per herd in five herds in a particular area would be monitored on a daily basis through a central office. Each farmer in the study would be furnished a flow meter for the cows being monitored. In addition he would be equipped with an extension telephone service

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[1] USGS Open File Reports No. 76–826; 76–876; 76–149; 80–453; 81–385; 81-378.

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and data transmitting console so that from the milking parlor he could relay his farm number, identity of the cows, and their production twice a day."[2]

The proposal to monitor milk and egg production as part of an earthquake warning system might sound bizarre. Yet, it advanced the view shared by all participants in the USGS study who insisted that animals' capabilities to detect extremely low levels of electric fields, odors, sounds, vibrations, and other geophysical and geochemical premonitors of seismic events surpass those of the physical instruments and should not be dismissed. "The sensitivity of the human nose is already remarkable," noted a physiologist participating in the study:

> "The thresholds of human subjects for several odorants are markedly lower than the minimum concentrations detectable by the flame ionization detector of a gas chromatograph. … A molecule of butyl mercaptan may be sufficient to stimulate a single human olfactory receptor. This implies an ability among animals to recognize and detect odorants in concentrations far below those … [that could be detected by] available physical instruments."[3]

As one of the participants in the USGS study has aptly put it, "Give me a stimulus and I'll give you an animal which could respond to it" (Enright, 1980, p. 228).

That animals often behave strangely before an earthquake has been known for centuries: there are stories from all over the world of dogs howling and barking minutes, hours, or even days before an earthquake, fish rising to the surface of the water, or snakes coming out of hibernation in the middle of freezing winter. Yet, the notion of animals as seismic sensors sits awkwardly with the practices, instruments, and information technologies that began to define earthquake studies since the 1920s and especially after WWII in the United States and Western Europe. A familiar story of seismology in the second half of the twentieth century is that of a small field focused on the studies of earthquakes through diverse disciplinary perspectives being transformed into a strategically important field increasingly focused on global studies of Earth's deep interior via sophisticated instruments and dense transnational networks of the seismological stations. With these developments, the sensorial and sensual experiences that occupied a central place in local earthquake studies in the nineteenth century moved to the outer fringes of global seismology in the twentieth century.[4]

Why then would an institution such as the USGS be interested in using animal senses at the time when seismology has become ever more global, specialized, and reliant on ever more sophisticated and standardized seismic sensors and instruments? One of the immediate motivations for the USGS study was the apparent success of the People's Republic of China's earthquake monitoring program, which predicted a devastating earthquake using the observations of abnormal animal behavior and mass monitoring citizen science programs endorsed in communist China.[5] Thus, the team from UCLA, introducing the above mentioned study of the activity of California's rodents before the quakes, referred to the "spectacular and widely publicized success of the Chinese [seismologists] in predicting the devastating Haicheng earthquake of 4 February 1975" that stimulated "the widespread interest … in reports of unusual animal behavior prior to earthquakes … among both scientists and laymen in the United States" (Evernden, 1980, p. 199).

While the case can certainly be made for the transnational story of "bioseismology" (see Fan, this issue), in this essay I offer a complementing story, highlighting the significance of local circumstances and disciplinary agendas that were contingent on transformations in the biological, rather than geophysical, sciences. In the 1960s and 1970s, alongside the rise of global seismology, linked to the postwar transformations in the physical sciences, biology was undergoing dramatic changes on its own, which determined the motivations of biologists who responded to the USGS' call. I argue that the Chinese studies served as a foil for a more complex story that tags the USGS earthquake prediction study to a wide range of concerns contingently specific to the American preoccupations of the time. In what follows I develop three examples illustrating the ways in which geophysics and biology have been reconciled in the USGS study through concerns over the use of seismological data, pioneering research on biological rhythms, and the troubled field of military brain studies.

1. Seismology and earthquake prediction in the 1970s

The Chinese earthquake prediction successes coincided with rapidly accumulated knowledge of the causes of the earthquakes, creating an anticipation in the 1970s that earthquake prediction was an "imminent" development, just around the corner. In April 1974, a year before the Haicheng earthquake, the US National Research Council of the National Academy of Sciences (NAS) convened a Panel on the Public Policy Implications of Earthquake Prediction, which expressed optimistic expectations common in the 1970s geoscience community: "within the past 5 years, many seismologists have become convinced that a new development is imminent, namely, the *prediction* of earthquakes, [that is] the place, time, and magnitude of the quake … specified within fairly close limits" (National Research Council, 1975, p. 24).[6] In the 1970s, the most common methods of earthquake prediction included mapping fault structures, the analysis of past incidences of quakes, and monitoring of such premonitory signs as uplift, foreshocks, and radon gas emissions (National Research Council, 1975, p. 24). While these methods apparently did not have much to do with biology, the USGS had a strong incentive to attract biologists as potential new *users* of seismic data.

In the 1970s, the USGS operated the largest global seismic network collecting seismic data on unprecedented scale. The first global seismic network was established during the International Geophysical Year (the IGY, 1957-58), with standardized instruments and standardized protocols for data types and formats that enabled global data exchange in seismology.[7] In the early 1960s, an expanded World-Wide Standardized Seismograph Network (WWSSN), which relied on new types of long-period seismographs developed to detect ground movements at large distance, was established in connection with nuclear test ban treaty negotiations. WWSSN was initially funded by the Department of Defense. In 1972, the USGS took charge of the WWSSN and expanded the range of data that were collected on seismic events, especially at "geographical locations of special interest" such as the San Andreas Fault. The facilities for storing, copying, and distributing seismic data, first established in Washington, D.C., were moved to Boulder, CO, merging with NOAA and Environmental Data Service (National Research Council, 1977).

[2] Verosub, Lott, and Hart (1979), p. 143.

[3] Moulton (1980), p. 157.

[4] See Coen (2013). On the transformation of seismology in the second half of the 20th century see Barth (2000, 2003).

[5] See discussion of the ways in which the Chinese findings stimulated the studies in the US in Fan (this issue). On the history of Chinese earthquake prediction program see Fan (2012).

[6] See discussion in Olson (1990).

[7] Elsewhere I discuss the IGY seismic network and data exchange in detail, see Aronova (2017a, b).

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