



SEISMOLOGY

Human Activity May Have Triggered Fatal Italian Earthquakes, Panel Says

ROME—A pair of deadly earthquakes that struck the north of Italy in 2012 could have been triggered by the extraction of petroleum at a local oil field, according to an international panel of geoscientists.

The group's long-awaited and as-yet-unpublished report, commissioned in the wake of the disaster that killed 27 and injured hundreds in the Emilia-Romagna region, could have important political and economic ramifications, some scientists say. While previous studies in other countries have linked earthquakes to gas and oil exploration, human casualties have been very rare. Fear of humanmade seismicity has already triggered fierce opposition against new oil and gas drilling efforts in Italy, and Vasco Errani, the president of the Emilia-Romagna region, announced in May last year that all new requests for hydrocarbon exploration in the quake area would be put on hold until the commission delivered its report.

Sources with close knowledge of the study say it was presented to the Emilia-Romagna regional government at least a month ago, but that politicians at both the regional and national level are nervous about its effects and are delaying its release. Although phrased cautiously, the panel's conclusions could lead the presidents of Italy's regions to turn down new requests for fossil-fuel exploration; existing production could also be hit.

The panel, known as ICHESE, was asked in late 2012 to review possible links between hydrocarbon production and the earthquakes, a magnitude-5.9 event on 20 May 2012, and a magnitude-5.8 event 9 days later. ICHESE consists of two Italian and three foreign geoscientists—including

the chair, Peter Styles of Keele University in the United Kingdom—as well as Franco Terlizze, an engineer at Italy's Ministry of Economic Development.

In its report, dated February 2014, ICHESE refutes one alleged factor: the development of a 3.7-billion-m³ natural gas deposit in an aquifer above an active



geological fault near the village of Rivara in the Po Valley, close to the two epicenters. Drilling for the facility had yet to begin when the quakes struck. But the panel does finger another site: the Cavone oil field, owned and operated by Gas Plus. *Science* has seen the conclusions of the report, which says it "cannot be excluded" that activities there initiated the 20 May quake, whose epicenter lies about 20 km away.

Changes in stress and pressure within Earth's crust resulting from both the removal of oil and the injection of fluids to enhance oil flow would almost certainly not have been sufficient on their own to have induced a major earthquake, the experts explain. But it is possible that the fault involved in the 20 May tremor was close to the breaking point, and that the human-induced changes in the crust, although extremely small, were

enough to "trigger" the earthquake. That quake could in turn have triggered the 29 May event by further altering crustal stress.

The group reached this conclusion on the basis of a correlation between increased output from the Cavone field beginning in April 2011 and rising seismicity in the area before 20 May 2012. They say this link should now be backed up by a physical model incorporating "the fluid dynamics in the reservoir and in the surrounding rocks."

Styles did not respond to questions about the report, and a spokesperson for Gas Plus says the company cannot comment on the findings. But an earth scientist who asked not to be named argues that several factors rule out a connection between crude oil production at Cavone and the 20 May earthquake: an absence of small quakes induced directly by the oil production, **the significant distance between oil field and epicenter, and the plant's modest output of about 500 barrels a day.**

Geoffrey Abers of Columbia University cautions that these factors wouldn't necessarily rule out a link. Three tremors with magnitudes between 4.5 and 5 in Denver in 1967 have been attributed to chemicals being pumped down a deep well, he notes, even though injection had stopped more than a year earlier and taken place up to 10 kilometers from the quakes' epicenters. And three quakes with magnitudes 5 and above that occurred in Oklahoma in November 2011 were probably a result of wastewater being pumped into a depleted oil well, even though the volumes involved were quite small. "We think that in Oklahoma the injected water was jacking up the pressure in just the right place," Abers says, "and that caused a cascading sequence of earthquakes."

Some Italian geologists worry the political noise that the report could generate will discourage rational and open discussion about the seismic risks of oil and gas development. Similar fears were aired after the L'Aquila earthquake, which killed more than 300 people 5 years ago this week. In its aftermath, seven experts were each sentenced to 6 years in prison for downplaying seismic risk ahead of the deadly event, a sentence that some, though by no means all, scientists believed betrayed ignorance by the public and the judiciary about the uncertainties inherent in science. An appeal in the L'Aquila case is pending.

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