Geological Society of Australia
Earth Science Showcase

Monday 22 June 2009

No end in sight as devastating volcano continues spewing scalding mud into drowning suburbs, says Australian Earth Scientist involved in international disaster response

A devastating mud volcano that first erupted three years ago in the city of Sidoarjo, Indonesia—engulfing eleven suburban villages and displacing approximately 40,000 people—continues to spew out 100,000 cubic metres (or 50 Olympic-sized swimming pools) of scalding hot mud each day and could continue at that rate for the next 30 years, according to an Australian Earth Scientist who has been researching the volcano as part of an international response to the disaster and has just returned from his latest trip to the disaster site.

"Early in the morning of 29 May 2006, hot mud erupted from the ground in the densely populated Porong District of Sidoarjo. With initial flow rates of around 5000 cubic metres per day, the mud quickly inundated the area" said Dr Mark Tingay of Curtin University of Technology, speaking as part of the Geological Society of Australia's *Earth Science Showcase* following the third anniversary of the eruption starting.

"Since then, the so-called Lusi eruption has increased in strength, expelling over 100,000,000 cubic metres of mud at flow-rates of up to 170,000 cubic metres per day. The mud—which is now being prevented from spreading outwards by hastily erected walls—has covered over 7 square kilometres of land at depths (so far) of up to 30 metres.

"Around 100,000 more people remain under threat from the continuing subsidence of surrounding land into the volcano's vent hole (called the Big Hole) which is approximately 100 metres wide. In effect, the whole region around the vent hole is sinking by about 2-5 centimetres each day due to the rising mud level, causing more damage to suburban villages and triggering frequent bursts of flammable gas around homes. GPS technology has even shown that, at times, the land has sunk by up to 3 metres in 12 hour periods.

"The damage caused by the mud flow so far has been estimated at over US$4.9 billion.

"There is still controversy regarding what triggered the eruption" said Dr Tingay, Postdoctoral Fellow and Lecturer with the Department of Applied Geology at Curtin University of Technology. "While some scientists believe it was triggered by a magnitude 6.3 earthquake that occurred 250 kilometres away in Jogyakarta two days earlier and killed 6000 people, others believe it resulted from a nearby drilling accident which could have extensively fractured the local geology and created flow pathways to the surface for the mud.

"The first quantitative analysis of the Yogyakarta earthquake, undertaken by myself and colleagues in 2008, indicates that this earthquake was likely too small and too far away to have triggered the mud flow. Also, at least two earthquakes (and possibly dozens) have caused stronger ground-shaking at the Lusi site in the past 30 years without causing an eruption. However, there are still conflicting opinions about whether a drilling accident could have caused the mud flow, and it is likely that the trigger for Lusi may never be conclusively proven either way.

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“Mud volcanoes are relatively common features in some areas of the world—but Lusi is altogether different. Where most mud volcanoes flow at a slow rate for a long time and are punctuated by occasional violent eruptions, Lusi has been flowing at a very significant rate for over three years. This is also the first time we have been able to analyse a mud volcano since its birth—most existing mud volcanoes are already many hundreds or thousands of years old.

“While we predict that Lusi could flow at its current rate of 100,000 cubic metres of mud per day for the next 30 years—that is, an incredible 1095,000,000 cubic metres of mud in total (over twice the volume of Sydney Harbour)—this is really only an estimate. The high flow-rate may only continue for 2-3 years, or it might continue for hundreds of years. Basically, Lusi will die out when pressures in the subsurface reach equilibrium with the surface—but we have little information about what volume of fluid is feeding the eruption from underground. And like other mud volcanoes, Lusi will probably be in existence for thousands of years, even if its flow-rate subsides.

“To visit the Lusi eruption site is somewhat surreal—in an effort to manage the mud flow, heavy excavators have been placed on pontoons in the middle of the mud field to push the mud towards the nearby Porong River so it can be removed. A few of these excavators have even overbalanced and toppled into the mud.

“A number of people were also killed in November 2006 when subsidence around the eruption site led to a landslide which ruptured a gas pipeline which then exploded in a 50 metre high fireball. The fireball resulted in 14 dead and 13 injured. A further three people have also been killed in related heavy equipment accidents.

“The mud being spewed out by Lusi is between 70-100ºC in temperature, and fluids driving the eruption are estimated to be coming from up to 3 kilometres underground. At the eruption site there are slightly elevated levels of organic compounds like benzene, toluene, xylenes and hydrocarbons—and potentially lethal levels of hydrogen sulphide were emitted for the first two days of the eruption resulting in respiratory illness for thousands of locals. While some early samples taken by the UN showed elevated levels of heavy metals (particularly mercury) in the mud, later surveys have shown that the mud is not toxic and is safe to be used or disposed.

“There have been numerous failed attempts to stem the flow of mud at Lusi. These have included trying to drill wells close to the eruption site in order to inject high density fluid to plug the mud flow deep underground (unsuccessful) and dropping around 400 concrete ‘ball and chains’ into the volcano’s crater to block the mud flow (also unsuccessful, given the balls probably disintegrated or melted after being dropped down the hole).

“There has also been a proposal to build a 50 metre high circular dam wall completely around the vent hole, in the belief that the raised mud level may exert enough negative pressure to stop the mud flow beneath it. The proposal even includes the integration of an apartment and sports complex into the dam wall! However, building such a dam would be a difficult project and it is unlikely that it would be successful.

“In the meantime, the best solution seems to be the current one of mixing the mud with river water and pumping the mixture into the Porong River.

“My research has focused on the anatomy, mechanics and evolution of the mud flow as well as the trigger. I am currently collecting data from nearby oil wells to try to ascertain the forces driving the mud flow, as well as looking at the geological faults that were present prior to the eruption—and those currently forming in the area—to help understand how the mud flow is evolving and whether there is any risk of the whole area collapsing into itself, a scenario that would cause untold devastation. I am also examining seismic data collected at an ancient buried geological feature 7 kilometres away that may be a similar mud flow event from 500,000 years ago—this may help gauge how big Lusi could become.”

Dr Tingay’s research is being funded by Curtin University of Technology and he is actively collaborating with scientists from Indonesia, the United Kingdom and the United States—as well as the local Sidoarjo mud flow management agency—as part of the international disaster response effort.

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Available for interview:
Dr Mark Tingay (photos are available of both Dr Tingay and the Lusi mud eruption site).

Also available for interview:
GSA Executive Members who can speak about Earth Science in general and the wide variety of exciting career paths it can offer.

Media contact:
Patrick Daley, Patrick Daley PR, tel: 0408 004 890.

Important request to media
The Geological Society of Australia is seeking to promote Earth Science and careers in Earth Science to the Australian public and most importantly students. Please assist us to do this by mentioning in any interviews or articles that this story is part of the Geological Society of Australia's *Earth Science Showcase*. Members of the public interested in subscribing to this free service to receive regular media releases on Earth Science research can do so by emailing mediasubscribe@gsa.org.au with the following details: preferred email address, name, state, age (optional), organisation (if any) and phone number (to assist with clarification of email details if required). Media are also requested to mention that the Society's website, www.gsa.org.au, is a good source of information on Earth Science.