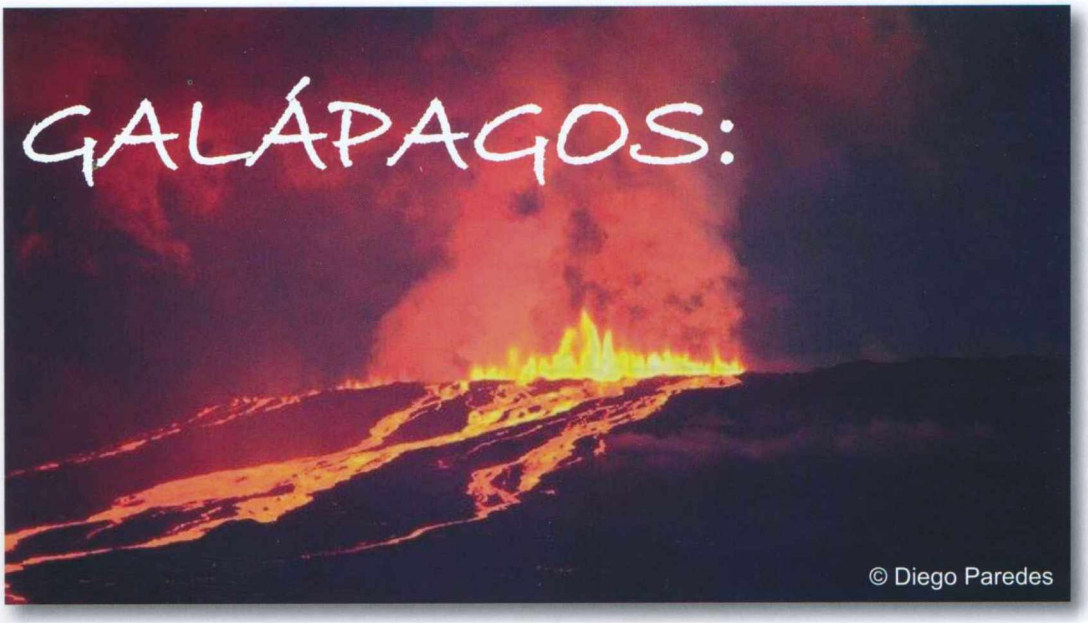


Ecuador is playing with fire...

Joël Lodé (Spain)

In May, 2015, a new eruption of the volcano Wolf on the island of Isabela fired the sky and land of Galápagos, Ecuador. The Ecuadorian authorities and the National park assumed that everything was under control, and that the endemic pink iguanas of which there are no more than 450 or 500 specimens and the giant tortoises were out of the danger area of eruption.

How can they really say that? In what danger are the endemic cacti?

Here is an article without concession, which tries to review the possible loopholes of the protection system of the biodiversity in Ecuador...

It is not a secret: the Galápagos islands are of volcanic origin; are from a relatively recent geologic past (+- 10.000 years) eruptions took place on Darwin and Ecuador volcanoes, on Genovesa, San Cristobal and Santa Cruz islands. Still more recently, in historic times, during 200 years, more than fifty eruptions were observed in the Galápagos from Wolf, Alcedo, Sierra Negra and Cerro Azul volcanoes on Isabela, and on Fernandina, Santiago, Pinta, Floreana and Marchena islands. The eruption of May, 2015 of the volcano Wolf, located north on Isabela island, peaking to 1710 m, the highest point of Galápagos, continues therefore in a long series of eruptive episodes, of which a dozen are known since

Satellite view of Fernandina, Isabela and Santiago.
© Source : courtesy of NASA

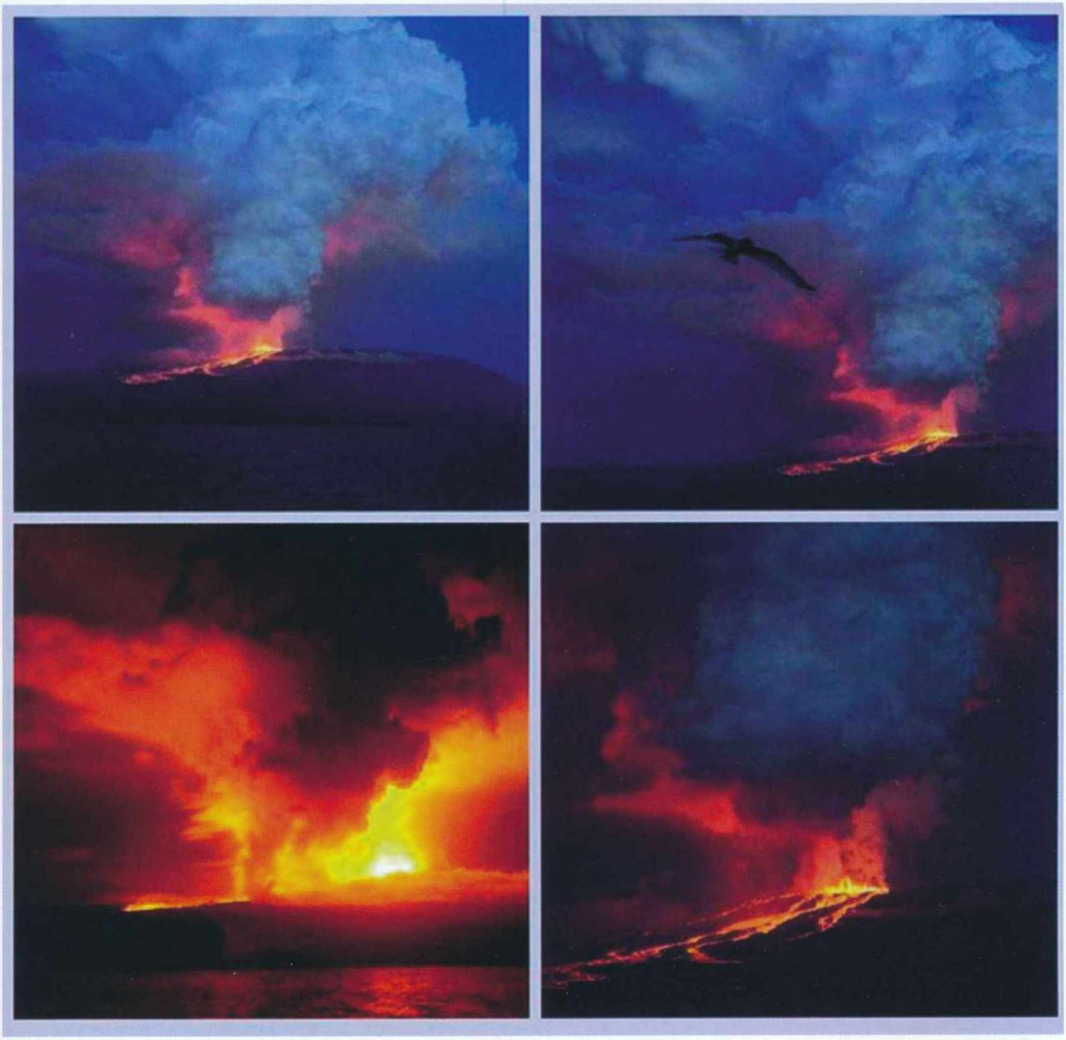
1797 and the last but one was only 34 years ago, in 1982. Another one also took place in 1963.

Isabela is a suite of eruptive cones (shield volcanoes) which created the current shape of the island, looking like a sea horse. The volcano Wolf is located north and is accompanied on the West by the volcano Ecuador and further South by Darwin, Alcedo, Sierra Negra and Cerro Azul volcanoes.

One might therefore legitimately ask the following question of the potential or real danger which exists for the fauna and flora endemic populations and the threat which could affect them and their future.

Some recent eruptions in the Galapagos Islands

Isabela	**volcan Wolf** : 1797, (1797, 1963, 1982, 2015), **Darwin** (1801), **Alcedo** (1946-1960, 1993), **Sierra Negra** (1813, 1911, 1948, 1953, 1954, 1957, 1963, 1979, 2005), **Cerro Azul** (1959, 1979, 1998, 2008)
Fernandina	1825, 1968, 1988, 1991, 1995, 2005, 2009
Marchena	1991, 1992



Volcan Wolf, Isabela, 05-2015.

Opuntia insularis in Isabela and its pollinator, ***Xylocopa darwinii*** © María del Mar Trigo Pérez

Most remarkable Cactaceae and land Reptiles of Isabela Island

Brachycereus nesoticus	***Conolophus marthae*** (Wolf)
Jasminocereus thouarsii sclerocarpus	***Chelonoidis becki*** (Wolf)
Opuntia echios inermis	***Chelonoidis microphyes*** (Darwin)
Opuntia insularis	***Chelonoidis vandenburghi*** (Alcedo)
Opuntia saxicola	***Chelonoidis guentheri*** (Sierra Negra)
	Chelonoidis vicina (Cerro Azul)

Opuntia insularis in Isabela © María del Mar Trigo Pérez

As no one seems to have published studies on the real impact of the successive volcanic eruptions on the populations of fauna and flora, we are going to try to review the situation with some representative species of Isabela island, and also try to gain a better idea of the whole dynamics situation, although we have unfortunately no clear answer to give.

If we read the official statements of 2015 reiterated through the whole world press, even before teams went on the spot, authorities were anxious to underline that NO species

was threatened by the eruption, the incandescent lava of which passed bythe giant land tortoises and the iguanas life areas (see map). Then, reconnaissance helicopter flights were organized during the eruption, one thanks to a private company and the other one thanks to the Ecuadorian armed forces; some samples of gases spewed by the eruption were taken, and precise statements of the eruptive episode which lasted more than 5 weeks were also undertaken.

Gases produced by volcanic eruptions are highly toxic, it is one of the most sneaky dangers of an eruption, because most of these gases are invisible: the 11_2O in the form of steam is harmless, but inside we find SO_2 (sulfur dioxide), CO_2 (carbon dioxide), which can turn into CO (carbon monoxide) extremely toxic poison for humans, animals and plants, HCl (hydrogen chloride), H_2S (hydrogen sulfide), HF (fluoride hydrogen); animals that eat plants containing the latter are poisoned and their bones are severely affected. The worst consequence is undoubtedly the formation of acid rain that pollutes all sources of water, destroy flora and poison countless living beings.

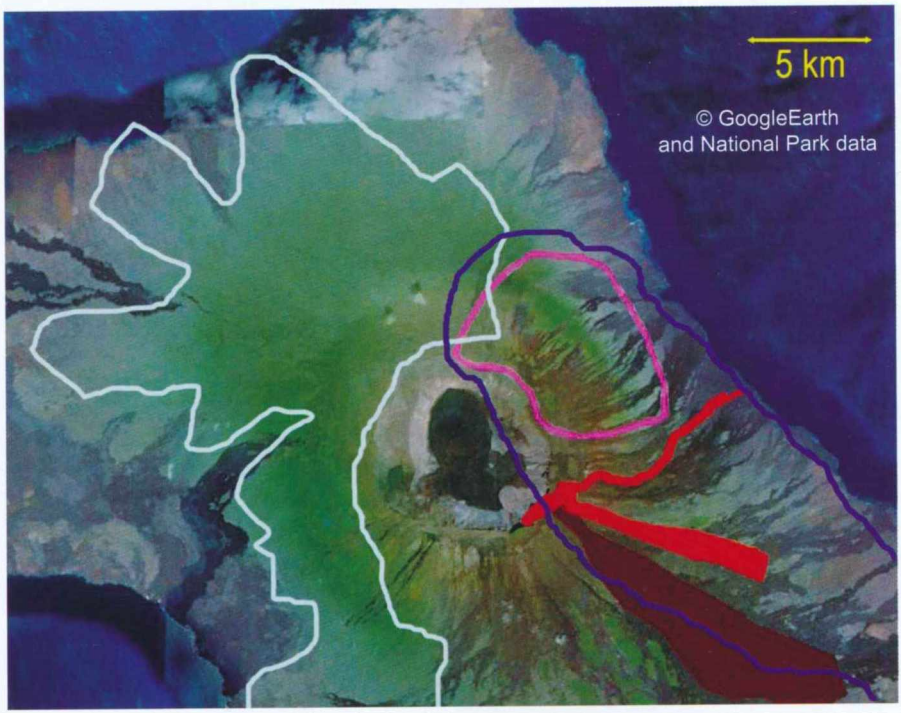
All this doesn't seem to exist on the Galapagos Islands since no reference to the destruction of cacti and animals linked to these phenomena is made... In the case of the 2015 eruption, the gas cloud and ashes rose to 15 kilometers high, not affecting the immediate vicinity of the volcano where no ash deposit was found. On June 12^{th} , a National Park team went close to the volcano in order to collect blood samples of the pink and yellow iguanas and giant tortoises. These samples were sent and analyzed by the University of Tor Vergata in Italy, but the results have apparently not yet been made known to the general public.

Endemic fauna in danger?

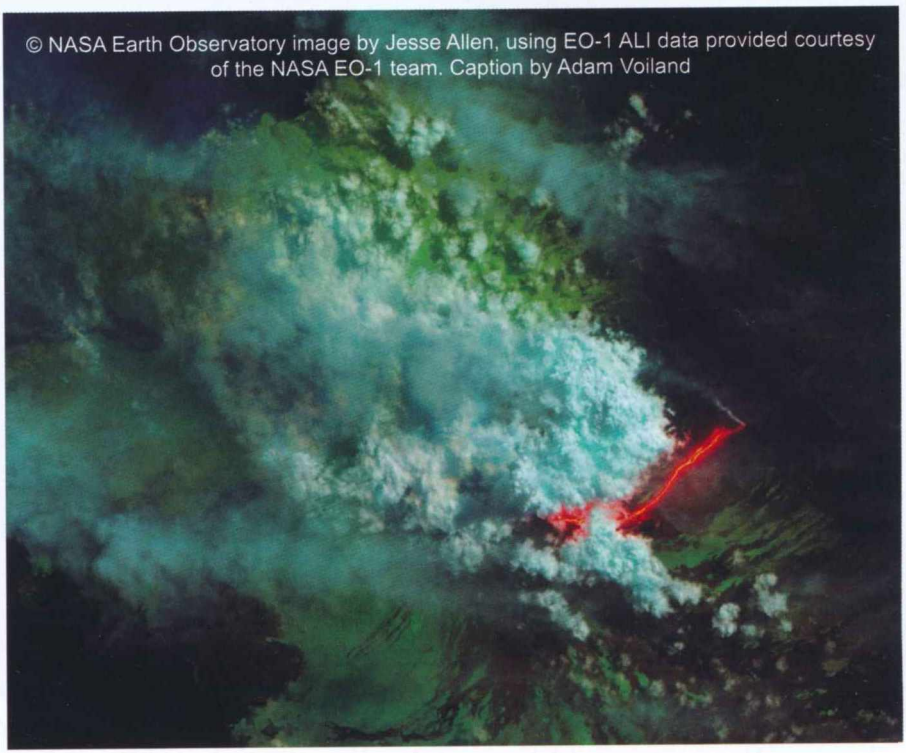
Chelonoidis becki: a very small population for a giant tortoise

We can find on the internet, pictures of giant tortoises walking among the fumaroles and gas clouds, local species are well in direct contact with this danger, but according to the Park authorities, they would apparently be not affected. From the documentation provided, I drew a map of the volcano, living and feeding areas of these reptiles, and superimposed the volcanic phenomenon (see next page).

There are 5 species of giant tortoises on Isabela Island, each beholden to a volcano (see previous list). Their diet consists mainly of fruits and stems of cacti and particularly *Opuntia* cladodes. The species encountered in the area of Wolf volcano, specifically in the west and northwest is ***Chelonoidis becki*** and is considered a vulnerable species. Toxic fumes can



: living and feeding area of the giant tortoises ;
: living area of the pink iguana : probable feeding area of the pink iguana
: incandescent lava flow : cooled lava; below, the huge eruptive gaz cloud.



Jasminocereus thouarsii sclerocarpus &Galapagos Mockingbird (***Nesomimus parvulus***)
on Fernandina island during an eruptive episode © Minden/Tui de Roy

Jasminocereus thouarsii sclerocarpus pretty close to the Wolf crater © Minden/Tui de Roy

affect and poison or kill the plant species including those tortoises feed on, even the tortoises themselves, which would explain in part (with predation by feral dogs and cats since their introduction by humans) why their number remains small even at the limits of extinction. Moreover, it is extremely difficult for them to escape the danger of eruption due to their relatively slow to move.

Conolophus marthae : its future is not all rosy

Another emblematic species of the Wolf volcano is a recently described Iguana (***Conolophus marthae***, 2009), commonly named pink iguana because of its colour. The yellow iguana (***Conolophus subcristatus***) is common in several islands and also lives on Isabela. Although the pink iguana was seen in 1986 and in 1999, it was only in 2006 when 36 specimens of this species were eventually captured for study. This is partly due to the difficult terrain composed of lava and its relative inaccessibility. It is estimated that there is a population of about 450 to 500 individuals, but for now, park guards and scientists have seen less than 200, and 133 of them have been banded and equipped with passive transponders for monitoring and find them.

Pink Iguana ***Conolophus marthae***, in its habitat at the edge of the crater of the volcano Wolf.

This is a very old species anterior to other iguanas living in the Galapagos; it is believed that their arrival was made about 5.7 million years ago. According to Italian scientists from the Tor Vergata University who discovered the pink iguana, it would be the oldest example of species diversification.

Its food consists in low plants (***Lippia rosmarinifolia,*** a Verbenaceae), cladodes and fruits of *Opuntia* and probably *Jasminocereus* fruits fallen on the ground, as they are growing in the area. Predation by feral cats, dogs and rats must be high because only 3 juveniles have so far been observed. The fragile ecosystem allows iguanas to feed, and cacti seeds can germinate only after passing into their digestive system.

Past eruptions, a dozen only for Wolf volcano since 1797 have been able to drastically reduce the population of pink iguanas, since a reptile whose origin of population is calculated by millions of years is found to be nothing more than a small group on the verge of extinction. Their habitat, living and feeding area is located northeastern flank of the volcano onto the crater, located at 1710 m altitude. By thinking that a change in wind direction, or a gap opened on the other side of the volcano could have concluded the existence of these ancient reptiles also shows that the Ecuadorian authorities are playing with fire, and are not able to clearly save the endemic species of possible destruction whether natural or not.

2015, the year of this last eruption, will have served as a trigger to accelerate a captive breeding program for the species. I think we lose nothing to breed Galapagos species ex situ for reproduction. The constant problem faced by the Darwin Foundation is the lack of funds: the first study of the pink iguana represented a cost of approximately US $ 100,000, financed by the University of Tor Vergata in Italy, the Italian Ministry of Education, with the help of Galapagos National Park for the logistics.

Pink Iguana ***Conolophus marthae***, in its habitat. © Gabriele Gentile

Jasminocereus thouarsii sclerocarpus & Galápagos Mockingbird (***Nesomimus parvulus***) on Isabela island

© María del Mar Trigo Pérez

Flora : the Cactaceae

Regarding the five taxa representing cacti (***Brachycereus nesoticus, Jasminocereus thouarsii sclerocarpus, Opuntia inermis echios, Opuntia insularis*** and ***saxicola***), and growing on the island of Isabela, I have not found either a distribution map specific to these species; we may think that these populations are dispersed, scattered from one to another and thus *a priori* less vulnerable than consumers of fruits and dispersers of seeds. On Wolf volcano, we can observe that two taxa grow on the volcano's slopes: ***Jasminocereus thouarsii sclerocarpus*** and ***Opuntia insularis.***

Therefore, maintenance of life and biodiversity on the Galapagos Islands is both a miracle, or rather a chance, since it is one of the place with most active volcanoes in the world with a precarious balance between flora and fauna that remained for million years, and that the nature that created this fragile ecosystem could at any time take its course and remove all or part of the territories reclaimed from the ocean. Thus, a game of hide-and-seek against the elements continues for cacti, iguanas and tortoises, where only the survivors will the keys of future.

Text: JL

Photos : Gabriele Gentile, Google Earth, Diego Paredes, María del Mar Trigo Pérez, Minde/Tui de Roy, Nasa

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