correlated—they can be treated as independent variables, provided the number of targets N is large. Armed with that hypothesis, which they later checked numerically, the CNRS researchers exploited the fact that the distribution of the "global" first-passage time $\langle T\rangle$—that is, the mean value of T averaged over all starting positions—is an exponential. That, in turn, led them to an expression for τ's probability distribution, plotted on page 18.

Remarkably, Chupeau and her colleagues found that when τ is rescaled in terms of the global first-passage time, its probability distribution becomes universally applicable to any of the several complex search strategies the theorists considered. That is, although τ itself is dependent on the dimensionality and connectivity of the network and the specific rules a random walker follows to search it, the probability distribution for $\tau/\langle T\rangle$ is completely insensitive to them: All the data points the researchers obtained by numerically simulating the different strategies fall on the same curve.

After deriving the distribution, the team recognized its resemblance to the so-called Gumbel distribution, used to model extreme-value problems such as the likelihood of an electric current fluctuating above some critical threshold or the chances of a river reaching flood stage. That the distribution of cover times should follow the same statistics isn't entirely unexpected since τ, by definition, is the time it takes to find *all* the targets in a given domain and is thus the largest of the arrival times at each target. The bigger surprise is that short-time dynamics, in which correlations between time and trajectory are important, become irrelevant. So much greater is the time needed to find the last few targets in the limit of a large number of them that the correlations are apparently negligible to the statistics.

That's not to say that one search strategy isn't more efficient or better suited for a particular problem than another. To determine the distribution, mean, most probable value, or variance of τ for a specific strategy, one needs only to reverse the scaling in the plotted distribution. What's more, thanks to that direct and robust connection between first-passage and cover times, the researchers found that if you optimize search parameters to minimize $\langle T\rangle$, you will have automatically also minimized τ. As Voituriez puts it, "One and the same strategy minimizes both times—an entirely unexpected result."

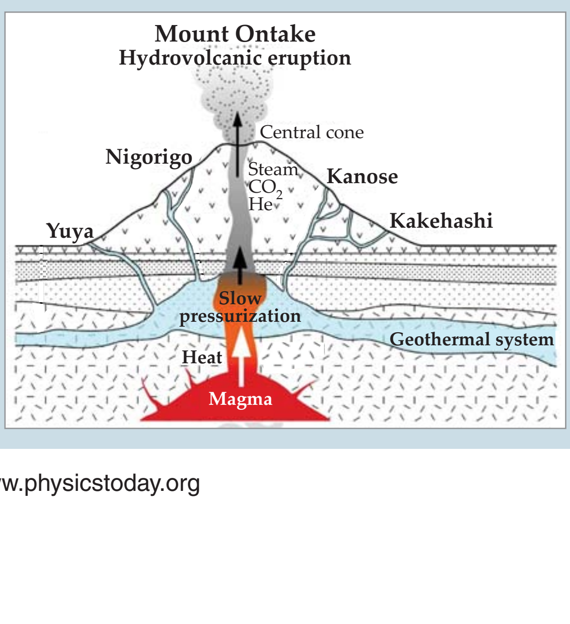
Mark Wilson

Reference

1. M. Chupeau, O. Bénichou, R. Voituriez, *Nat. Phys.* (in press), doi:10.1038/nphys3413.

be misaligned. Dynamo models that presume alignment will require modification. (A. Pastor Yabar, M. J. Martínez González, M. Collados, *Mon. Not. R. Astron. Soc.* **453**, L69, 2015.) —CD

A surprise eruption's decade-long buildup. On 27 September 2014 Mount Ontake in central Japan unexpectedly spewed an ash plume 7–10 km into the air and sent a deadly mix of hot gas and rock rushing down the south face of the mountain. The hydrovolcanic eruption, caused when rising magma heated groundwater into explosively expanding steam, killed more than 50 people. An international team of researchers led by Yuji Sano of the University of Tokyo now suggests that a warning sign may have been growing for years. The group had been periodically monitoring ratios of helium-3 to helium-4 in nearby hot springs since 1981. That ratio is a well-known signature of volcanic activity because changes in the relative abundance of ^{3}He, which originates in Earth's mantle, is often a telltale sign of changing magmatic activity. However, such a signature had never been observed before as a precursor to a hydrovolcanic eruption. At Mount Ontake, the ^{3}He/^{4}He ratio at Nigorigo, the spring closest to the volcano, steadily increased for 10 years prior to the eruption. At three springs farther afield—Yuya, Kanose, and Kakehashi—the ratio showed no significant change during the same period.



As illustrated in the figure, hydrodynamic models based on the group's data indicate that increased input of volatiles from the magma into the local geothermal system slowly caused pressure to build up in the volcano until it catastrophically erupted. Sano and his colleagues say the new findings can't be used to make short-term predictions, but they anticipate efforts like theirs could provide guidance on long-term risk management at Ontake and other volcanoes. (Y. Sano et al., *Sci. Rep.* **5**, 13069, 2015.) —SC

Quantifying scientific collaboration. Research collaboration is increasingly common in today's scientific world. The practice grows out of colocation, mentoring, complementarity, and other factors. Much of the "science of science" research has focused on collaboration patterns that emerge from data aggregated over individuals, time, and disciplines. Alexander Petersen of the IMT Institute for Advanced Studies in Lucca, Italy, has now analyzed collaborations, as manifested in publication and citation records, with a focus on the individual researcher. He considered the career data of 473 scientists, 193 from biology and 280 from physics. For a given researcher, Petersen quantified the tie to each coauthor based on duration (the time between first and last coauthored papers), strength (the number of coauthored papers), and impact (the number of citations to coauthored papers). The evolution of each researcher's network reflects specific career events such as relocations, discoveries, and major prizes. Petersen found that in both biology and physics, collaboration networks are dominated by weak, short-lived connections, especially late in one's career. But his analysis also revealed the existence of "super ties": extremely strong, long-duration collaborations that lead to above-average productivity and citation rates. Such super ties—the research analogue of a life partner—are thus a major factor in career development. Biologists tend to have more super ties than do physicists, yet the frequency of super ties for both groups is surprisingly high: typically one for every 25 coauthors, independent of a researcher's prestige or overall productivity. (A. M. Petersen, *Proc. Natl. Acad. Sci. USA* **112**, E4671, 2015.) —RJF ■