

## Evaluating possible risks and benefits of nanopesticides application

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Deliberate application of nanoparticles as plant protection products within agricultural practices could result in one of the rare intentionally diffuse inputs of engineered nanoparticles into the environment. The anticipated new or enhanced activity of nanopesticides will inevitably result in both new risks and new benefits to human and environmental health. It is unclear whether the current regulatory framework is adequate for the evaluation of these new products.

A literature review [1] was carried out with the objectives (i) to explore potential applications of nanotechnology within the pesticide formulation sector, (ii) to identify possible impacts on environmental fate, and (iii) to analyse the suitability of current exposure assessment procedures to account for their novel properties within the EU regulatory context. Nanopesticides encompass a great variety of products and cannot be considered as a single category. Nanopesticides can consist of organic ingredients (e.g., active ingredient(s), polymers) and/or inorganic ingredients (e.g., metal oxides) in various forms (e.g., particles, micelles). Studies on the environmental fate of nanopesticides are scarce. Possible effects of nano-formulations on the fate of the active ingredient can be complex and reported results are often contradictory.

The current level of knowledge does not appear to allow a fair assessment of the advantages and disadvantages that will result from the use of some nanopesticides. A great deal of work will be required to successfully combine analytical techniques that can detect, characterize and quantify the active ingredient and adjuvants emanating from nano-formulations, and also to understand how their characteristics evolve with time, under realistic conditions.

A more robust risk assessments framework for nanopesticides is urgently needed. In this context, priority for research are to (i) identify the assumptions currently applied that are not valid in the case of nanopesticides, (ii) evaluate the points or situations in which differences may impact significantly on the exposure assessment outcomes, and (iii) refine or adapt current assessment protocols as required.

[1] Kah *et al.* (2013) *Crit. Rev. Environ. Sci. Technol.*  
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## Characterizing magma migration dynamics beneath Mt. Etna using combined kinetic and thermodynamic (MELTS) modelling

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Characterizing the routes of magma migration beneath active volcanoes is important to understand the dynamic processes in sub-surface magma plumbing systems. We present a method that combines kinetic (diffusion) and thermodynamic (MELTS) modelling of the chemical stratigraphy preserved in zoned olivine crystals to constrain the nature and dynamics of magma storage and migration beneath Mt. Etna. We used 180 olivine crystals erupted during several episodes between 1991 and 2008. The compositional and zoning record preserved in these crystals reveal five different olivine populations (i.e. Fo<sub>79-83</sub>, Fo<sub>75-78</sub>, Fo<sub>73-75</sub>, Fo<sub>70-72</sub> and Fo<sub>65-69</sub>). These can be explained as the result of multistage magma mixing and magma exchange between at least four different magmatic environments (M<sub>0</sub> containing olivine of Fo<sub>79-83</sub>; M<sub>1</sub> with Fo<sub>75-78</sub>, M<sub>2</sub> with Fo<sub>70-72</sub> and M<sub>3</sub> with Fo<sub>65-69</sub>). Two dominant magma migration routes (M<sub>0</sub>-M<sub>1</sub>; M<sub>1</sub>-M<sub>2</sub>) have been identified in the majority of the studied eruption products and thus might represent major pathways for magma transfer. Kinetic modelling of the compositional zoning observed in the olivines reveal that most of the timescales related to the transfer of magma between the environments M<sub>0</sub>-M<sub>1</sub> as well as M<sub>1</sub>-M<sub>2</sub> is less than three months, though a minor population of longer timescales ranging up to 3 years was also found. Combining these results with thermodynamic modeling using the MELTS thermodynamic database [1], we aim to characterize the ambient intensive variables (e.g. P, T, fO<sub>2</sub>) along the two most prominent magma transfer routes (i.e. M<sub>0</sub>-M<sub>1</sub>; M<sub>1</sub>-M<sub>2</sub>). Comparison of the obtained results with compositions of other mineral phases (i.e. Cpx, Plag and Ti-Mt) allows elucidating the P-T-fO<sub>2</sub>-H<sub>2</sub>O-time history of the magmas before eruption.

[1] Ghiorso & Sack (1995), *Contrib. Mineral. Petrol.* **119**, 197-212