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Drying effects on mineral surface catalyzed atrazine degradation

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Atrazine, a popular herbicide, endocrine disruptor and possible carcinogen, is frequently detected in water systems. Its biodegradation in soils is well documented, but its degradation on soil mineral surfaces is only partially understood. Furthermore, changing global climate and increased temperatures could possibly increase occurrences of extreme drying (evaporation) in soils, a process known to affect various soil mineral surface reactions. Therefore, the first part of this study investigated atrazine degradation on the drying surfaces of Mn-oxide, Fe-oxide, Al-oxide, Al-saturated smectite and quartz. Atrazine degradation appeared to be controlled by surface redox potential, with the extent of degradation being: Mn-oxide (66%) > Fe-oxide (18%) » other surfaces (˜ 0%). The only degradation products formed were atrazine-2-hydroxy (A-OH) and atrazine-desethyl (A-DE). In part two, the effect of drying rate on degradation was investigated, by drying moist Mn-oxide-atrazine mixtures under gradual (ambient) drying conditions and rapid drying with an air stream. After 30 days of gradual drying, 90% of the atrazine was degraded, however the same extent of degradation was achieved after only 4 days of rapid drying. In part three, the reaction mechanism was investigated. The same rapid drying experiment was performed under a nitrogen (N₂) stream to eliminate oxygen (O₂) as possible oxidant. Dissolved Mn²⁺ was also measured in both rapid drying experiments to detect possible oxidation. No differences were found between air-drying and N₂-drying in terms of products formed and extent of degradation, with no Mn²⁺ being formed either. In all experiments, only A-OH and A-DE were formed, and degradation initiated only after drying to a critical gravimetric moisture content of 22%. It was concluded that atrazine was degraded by an overall net non-redox catalysis reaction on drying mineral surfaces, and that this degradation reaction is highly applicable in agricultural soils where extreme drying, due to windrowing/tilling, is possible.
KEYWORDS: atrazine, drying-enhanced degradation, mineral surfaces, catalysis, net non-redox

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