

Transport Characteristics of the Pharmaceutical *Oxaliplatin* in Natural Soil

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Introduction: Pharmaceuticals have been reported for over forty years to reach natural water and soil resources. The presence of pharmaceuticals in the environment raises concerns regarding their impact on ecosystems and human health, in spite of their minute environmental concentrations. Therefore, better understanding of transport and fate of pharmaceuticals in the subsurface could improve predictions of their environmental impact and facilitate the design of remediation efforts.

Goal: Determine the transport characteristics of the pharmaceutical oxaliplatin ($C_8H_{12}N_2O_4Pt$) in packed columns of saturated natural soil, under controlled and environmentally relevant redox conditions.

Oxaliplatin is a commonly used chemotherapeutic agent that has been detected in hospital effluents [1].

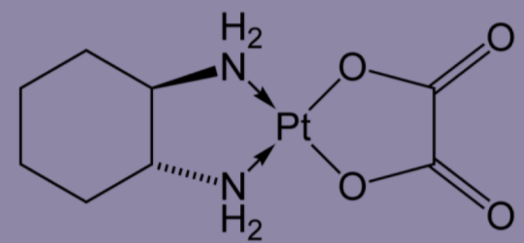


Figure 1. Oxaliplatin (395.27 g/mol)
Detected concentrations in wastewaters: ~150 ppt [2]

Oxaliplatin is prone to hydrolysis and ligand exchange as a function of pH and electrolyte activities; it is therefore a source of both mobile and sorbed Pt complexes in the subsurface [3,4].

Methodology

1. Soil is packed in columns and fully saturated.
2. The selected redox regime is stabilized in the column.

Regime	p_e+pH
Oxic	16.6 - 20.9
Nitrate reducing	12.5 - 14.2
Iron reducing	6.5 - 10.2
Methanogenic	5.6 - 3.9

Table 1.
Environmental redox regimes.

3. A solution of electrolytes, an inert tracer (Br^-) and oxaliplatin (600 ppb) flows through the column, and the effluent is collected in fractions.
4. Total Pt and Br concentrations in the fractions are measured by ICP-MS.

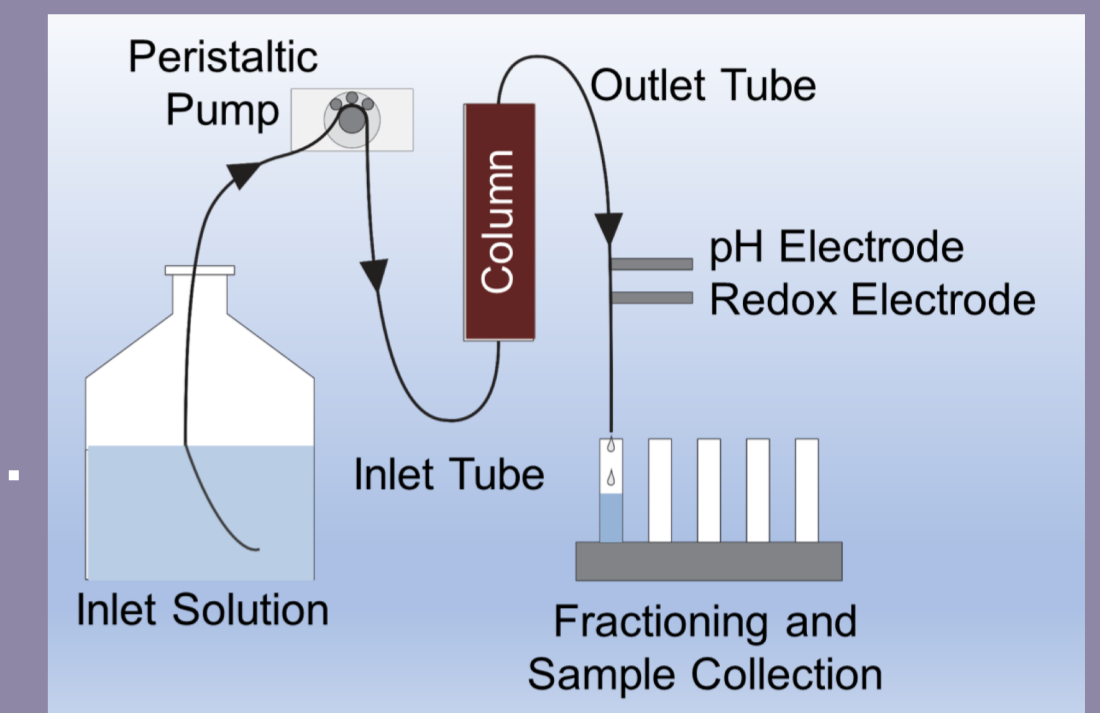


Figure 2. Experimental setup.

Component	Weizmann Soil
Sand	89% ± 3%
Silt	7% ± 4%
Clay	3% ± 1%
Organic matter (%)	0.5% ± 0.2%
Inorganic carbon (%)	0.14 ± 0.02

Table 2. Characteristics of Weizmann soil.

Results

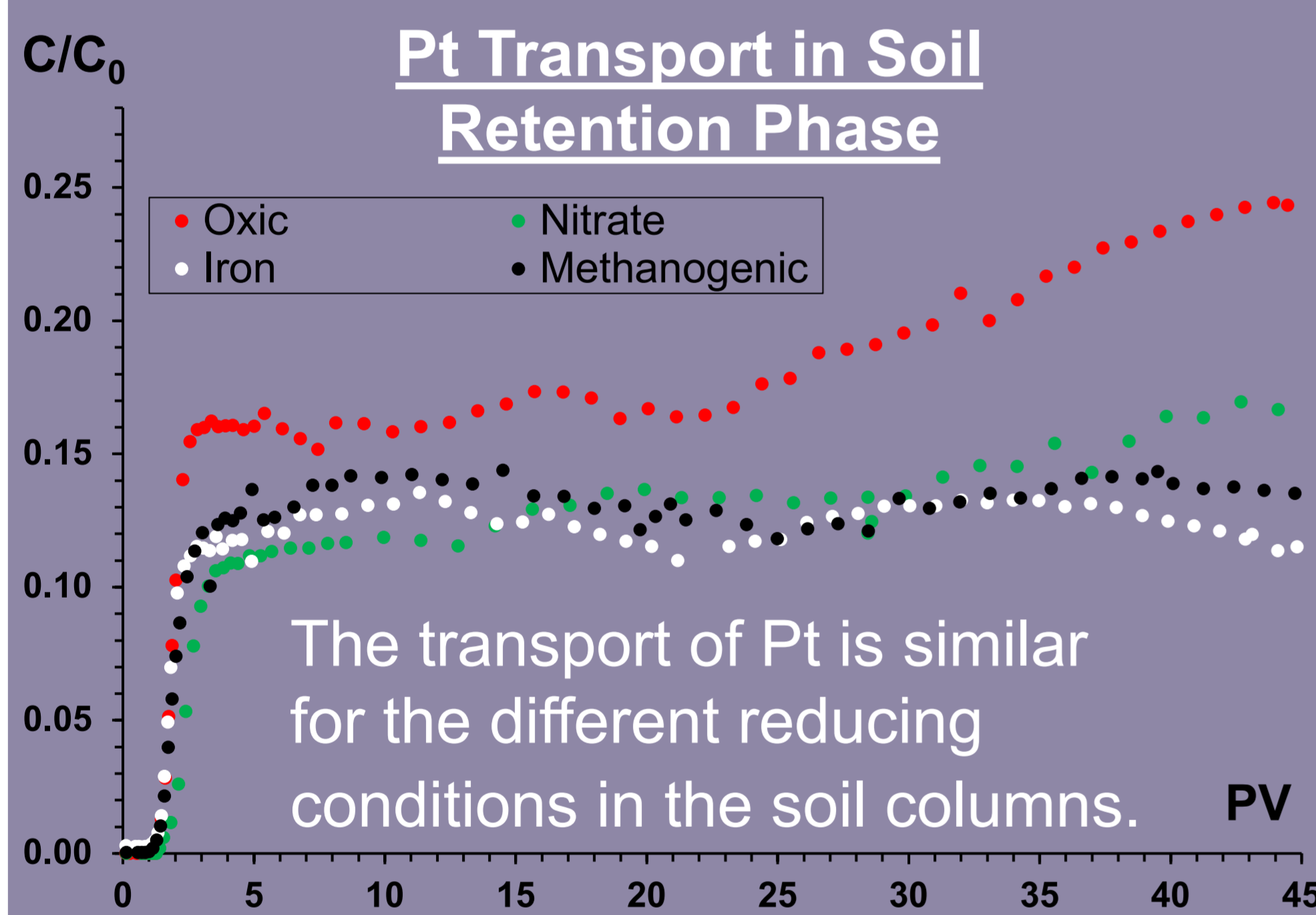


Figure 3. Transport of all Pt species originating from oxaliplatin, under different redox regimes, during the Pt pulse. During the pulse, the curves exhibit an initial fast retention phase, reaching a short-term plateau, followed by a slow, continuous increase in recovery, indicating slow release.

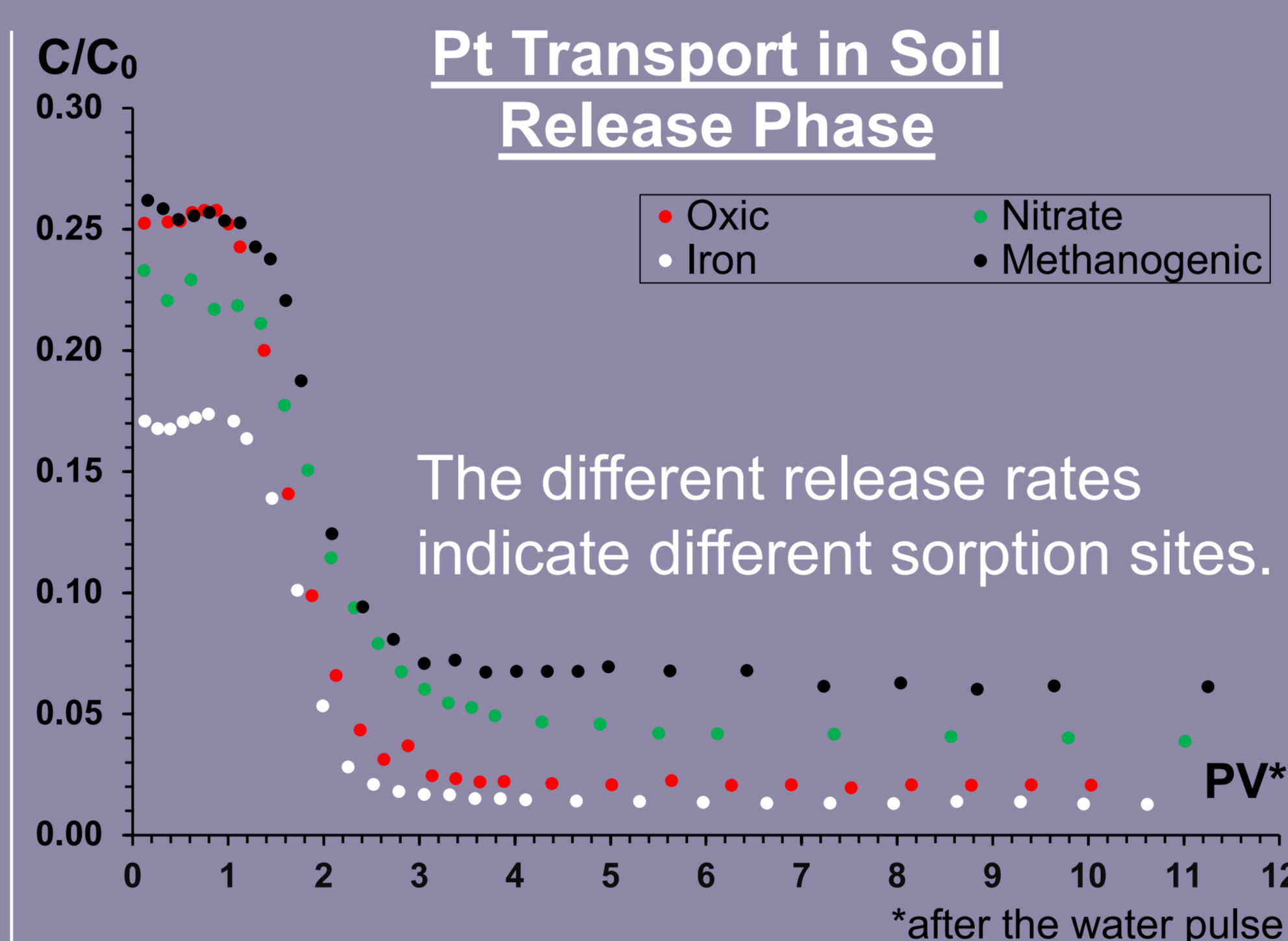


Figure 4. Transport of all Pt species originating from oxaliplatin, under different redox regimes, during the water pulse. Most of the release occurs as quickly as the initial retention, and the residual released species are spread over a long tail.

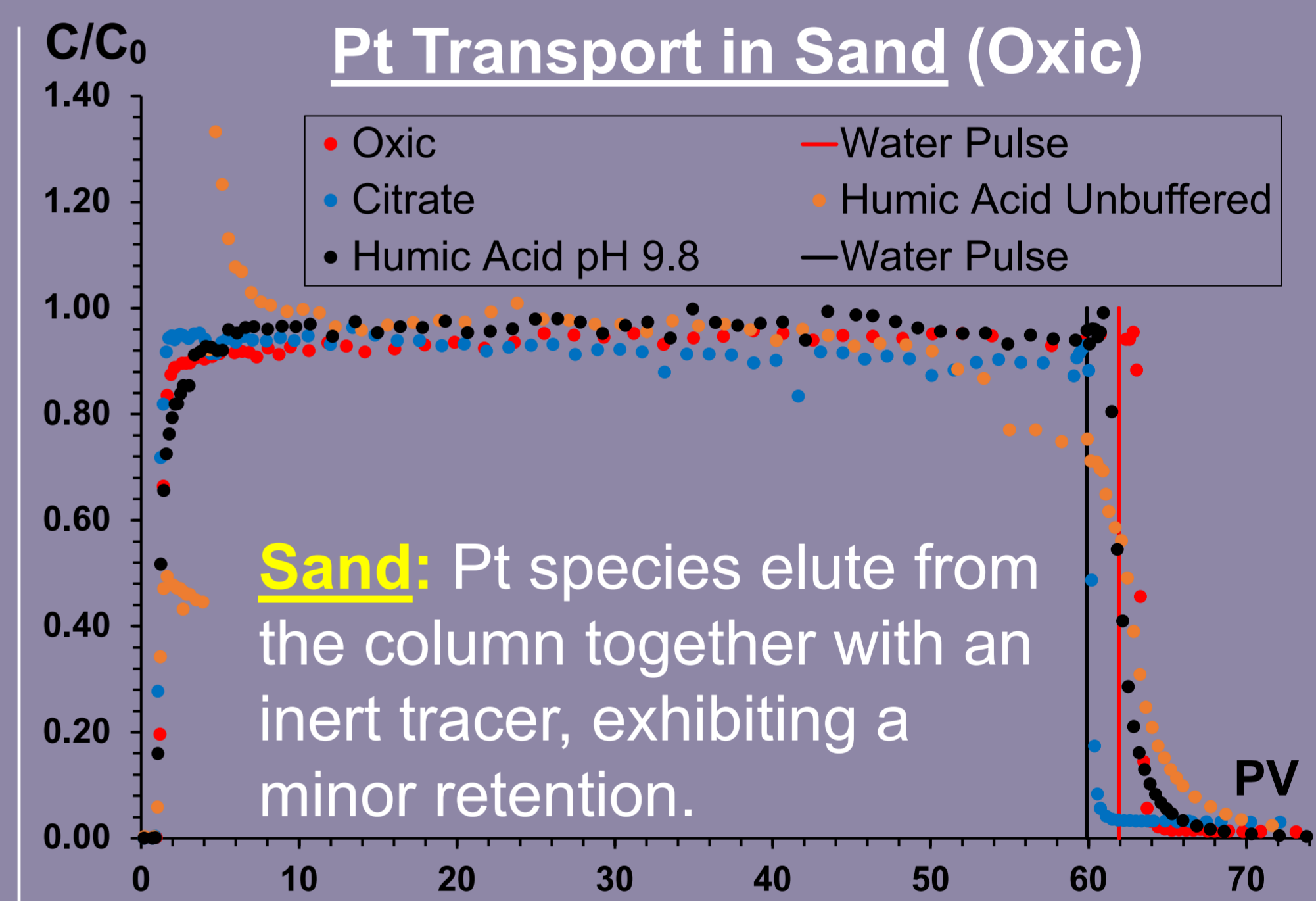


Figure 5. Transport of all Pt species originating from oxaliplatin, under oxic conditions in a sand column, during the Pt pulse and the water pulse. The transport was practically unaffected by different chelating agents in the inlet solution (citrate and humic acid).

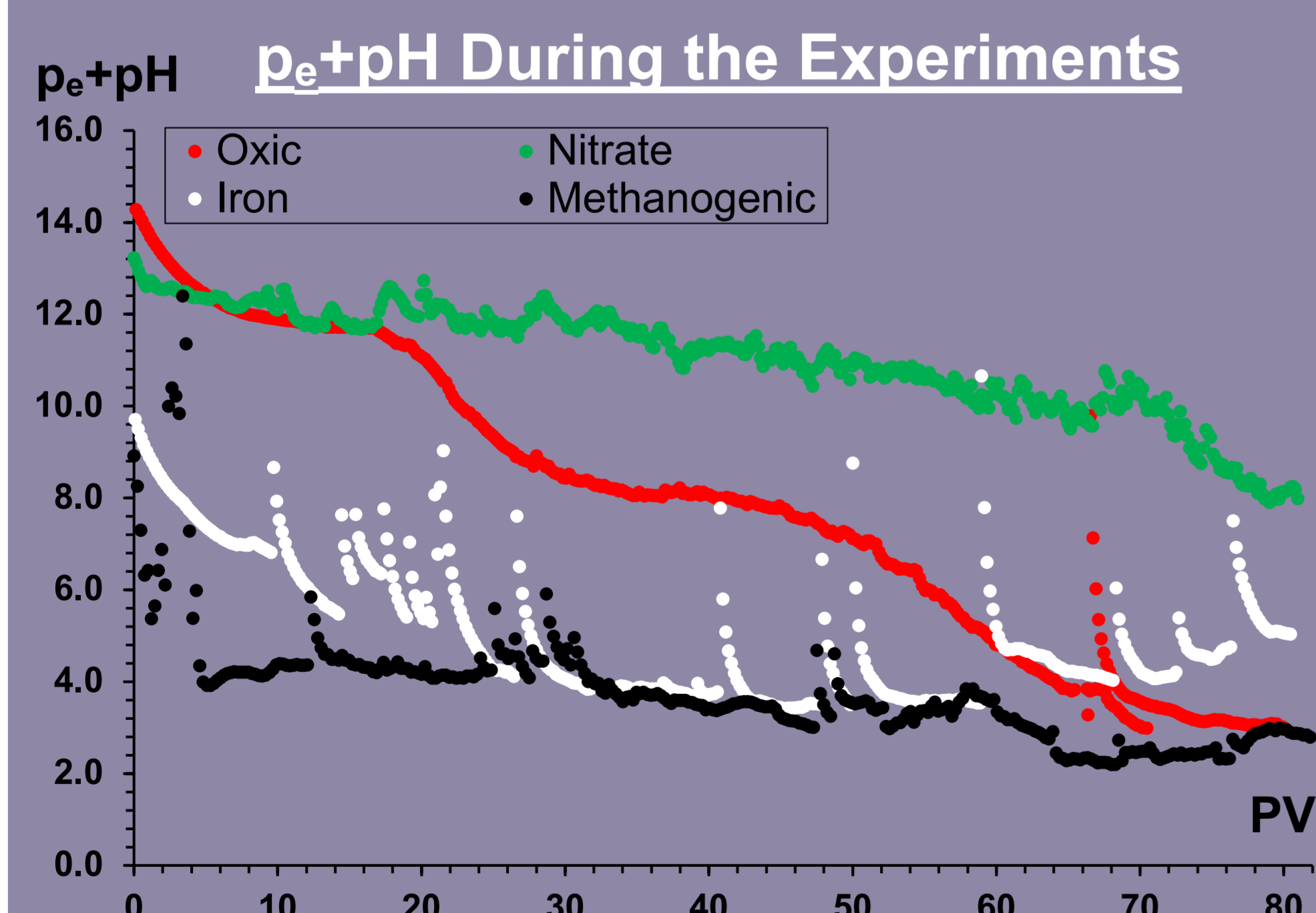


Figure 6. Changes in p_e+pH conditions within the soil column, under different redox regimes, throughout the experiments. See Table 1 in Methodology for literature values.

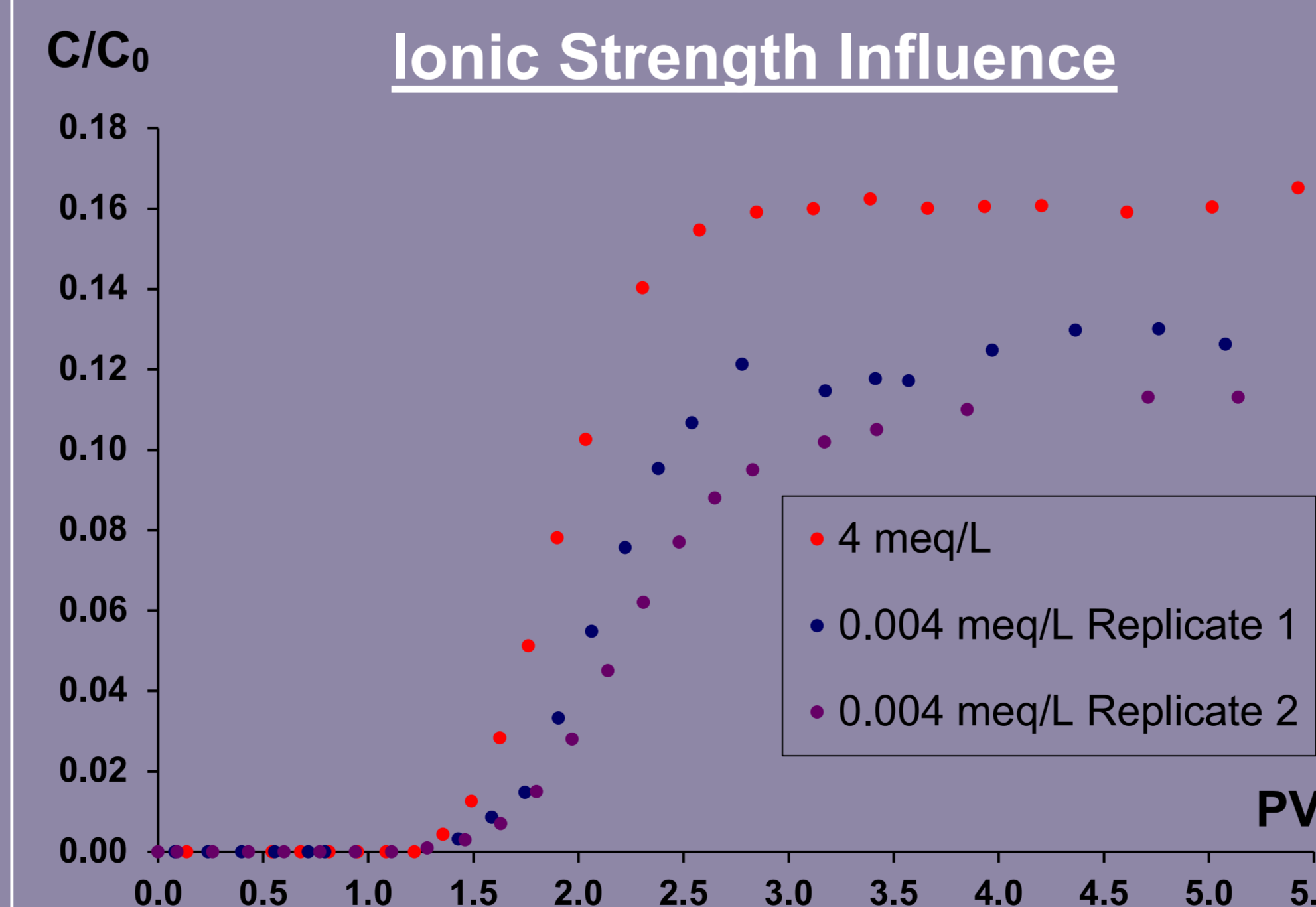


Figure 7. Transport of all Pt species originating from oxaliplatin during the Pt pulse, in a soil column, under oxic conditions induced by DDW vs oxic conditions induced by a simulated tap water. The breakthrough point is retarded by ~ 0.3 PV in the DDW experiments compared to the oxic experiments with simulated tap water.

Conclusions

- In soil, different redox conditions have a similar effect on oxaliplatin transport: fast retention of ~85% of C_0 , followed by a slower release.
- In sand, oxaliplatin transport is almost conservative.
- In sand, the presence of citrate or buffered humic acid in the inlet solution does not affect the transport, whereas unbuffered humic acid affects the transport significantly.
- In soil, transport is slower at low ionic strength of the inlet solution (0.004 meq/L vs 4 meq/L).