ORC TECHNICAL BULLETIN # 1.1.2

Oxygen Release Compound, ORC®

Early Proof-of-Concept in the Field

After successful laboratory demonstrations, the industry's need for this innovative and effective technology prompted Regenesis to conduct several large-scale field tests of ORC.

The oxygen barrier concept - involving the subsurface placement of ORC to effect remediation of dissolved phase hydrocarbons - was successfully demonstrated and the results published. The abstract from a **1993 study at the University of Waterloo** is as follows:

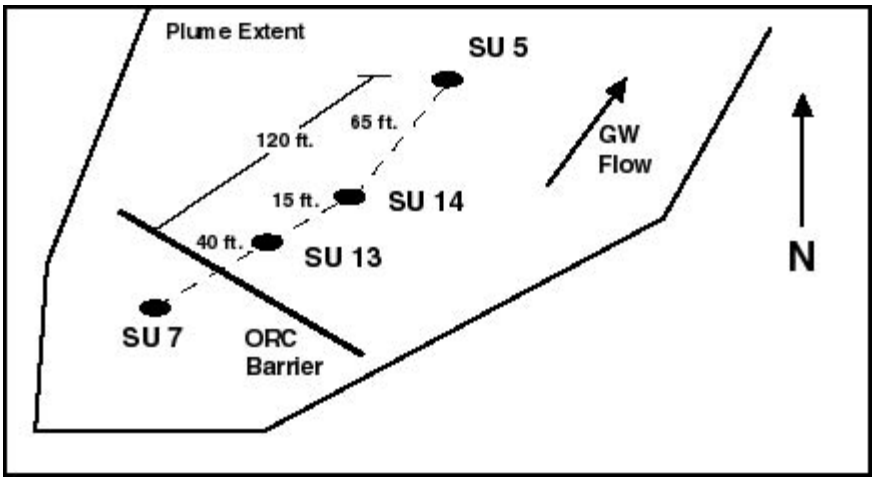
"A field test to evaluate the applicability of an oxygen releasing compound (ORC) to the remediation of ground water contaminated with benzene and toluene was conducted in the Borden Aquifer in Ontario, Canada. Benzene and toluene were injected as organic substrates to represent BTEX compounds, bromide was used as a tracer, and nitrate was added to avoid nitrate-limited conditions.'

'The fate of solutes was monitored along four lines of monitoring points and wells. Two lines studied the behavior of the solutes upgradient and downgradient of two large-diameter well screens filled with briquettes containing ORC and briquettes without ORC. One line was used to study the solute behavior upgradient and downgradient of columns of ORC powder placed directly in the saturated zone. The remaining line was the control.'

'The results indicated that ORC in both briquette and powder form can release significant amounts of oxygen to contaminated groundwater passing by it. In the formulation used in this work, oxygen persisted for at least 10 weeks. **Furthermore, the study indicates that the enhancement of the available dissolved oxygen content of the ground water by ORC, can support the biodegradation of at least 4 mg/L each of benzene and toluene.** Such concentrations are typical of those encountered at sites contaminated with petroleum hydrocarbons; therefore, these results suggest there is promise for ORC to enhance in-situ biodegradation of BTEX contaminants at sites using passive systems to contact the contaminated ground water with the oxygen source."

Bianchi-Mosquera, et al. (1994). Enhanced Degradation of Dissolved Benzene and Toluene Using a Solid Oxygen-Releasing Compound, Ground Water Monitoring and Remediation, (GWMR),Winter 1994.

A leaking UST at a trailer park in Leland, NC, generated a BTEX plume requiring clean-up with an ORC oxygen barrier. The work was done by **North Carolina State University** personnel. The site has a sandy aquifer with a groundwater velocity of about 1 foot per day. The average BTEX concentration moving through the barrier was 26 ppm. There was also elevated soluble iron in the system, on the order of 20-40 ppm; so the total flux of oxygen demanding compounds was quite high at the site. The site description is as follows:



The results of ORC remediation are as follows:

Heavy loading prevented full clean-up at the site, however, from a risk reduction standpoint there was significant contaminant reduction at a point about 120 feet downgradient (SU-5). Figure 1 shows the change from background oxygen in the system as measured at SU-14 after 200 days; noting that there is concurrent oxygen demand in the system. Figures 2 and 3 present BTEX degradation and risk reduction data for SU-5 at 200 days.

Biopiles

ORC has applications for soil remediation. Technical Bulletins 2.3.1 through 2.3.3 expand on the topic of using ORC in biopiles. Early proof-of-concept work included an in-house study on a crude oil contaminated soil. When the contaminated soils were treated with ORC there was a 7000 ppm greater reduction in TPH after 200 days, relative to the control.

ORC was used in an experiment with Dow Chemical in Midland, MI. The study was eventually presented in a poster session at the Third International Symposium for In Situ and On-Site Bioreclamation, April 26, 1995 (The Battelle Conference). The target problem was 20,000 to 30,000 cubic yards of soil at an oil well field service center. The contamination consisted of 0.1% to 5% by weight of total petroleum hydrocarbons (TPH). A sample of the contaminated area was taken and incorporated into an experiment. The relevant elements of the presentation abstract are as follows:

"Oxygen supplied to soil is often the single most important factor limiting bioremediation of petroleum containing soils. One approach for increasing the rate of TPH removal (and decreasing treatment times) is through enhancing the supply of oxygen to the soil. **The introduction of solid oxygen releasing compounds into soil provides a viable alternative for meeting the oxygen demand of petroleum contaminated soils."**

Odor Control

ORC was demonstrated to control odors by the neutralization of reduced sulfur and nitrogen compounds and the inhibition of their microbial producers. A major environmental firm, IT Corporation, tested ORC and compared it to nitrates for hydrogen sulfide control in an industrial effluent lagoon. The results were presented at the 1992 annual meeting of the American Chemical Society in Atlanta, GA. The full details of the study are presented in Technical Bulletin 2.3.5.

Figure 1

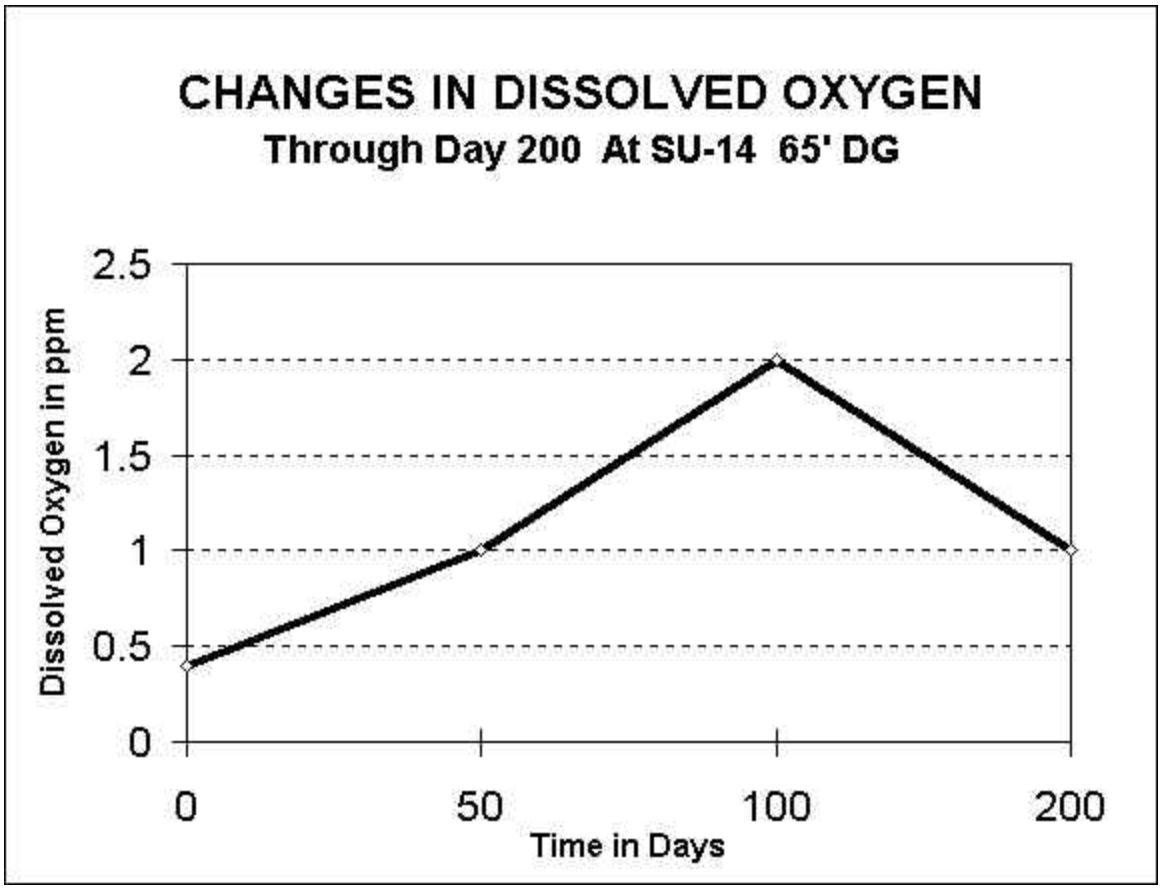

CHANGES IN DISSOLVED OXYGEN
Through Day 200 At SU-14 65' DG
Dissolved Oxygen in ppm
2.5
2
1.5
1
0.5
0
0
50
100
200
Time in Days

Figure 2

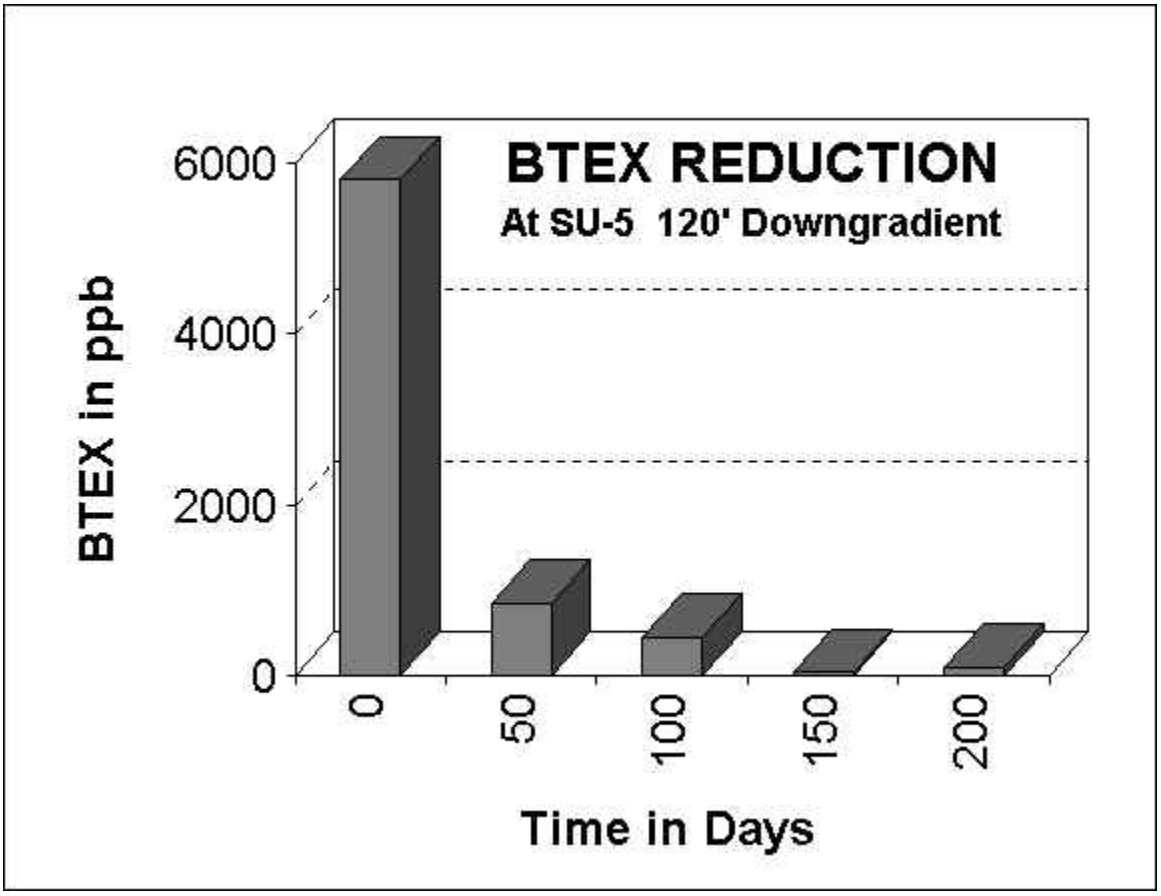
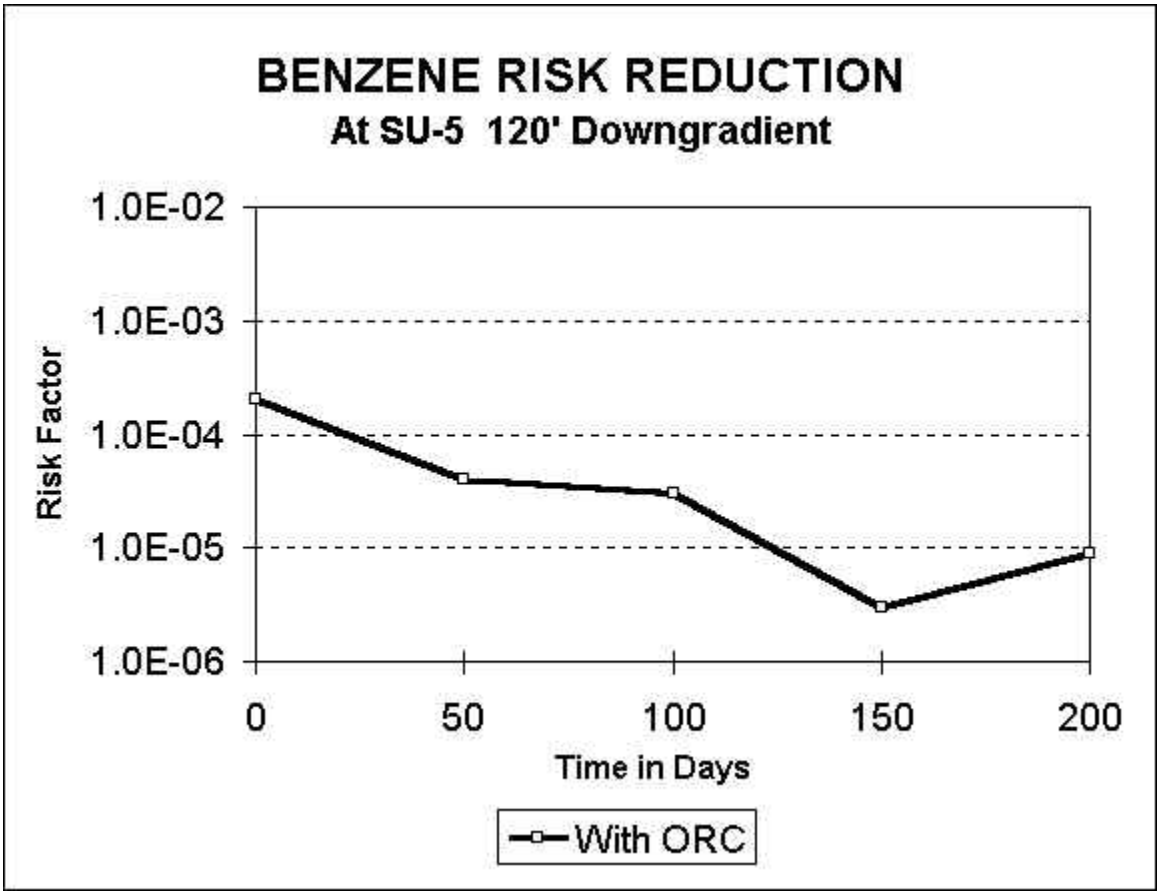

BTEX REDUCTION
At SU-5 120' Downgradient
BTEX in ppb
6000
4000
2000
0
0
50
100
150
200
Time in Days

Figure 3



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