

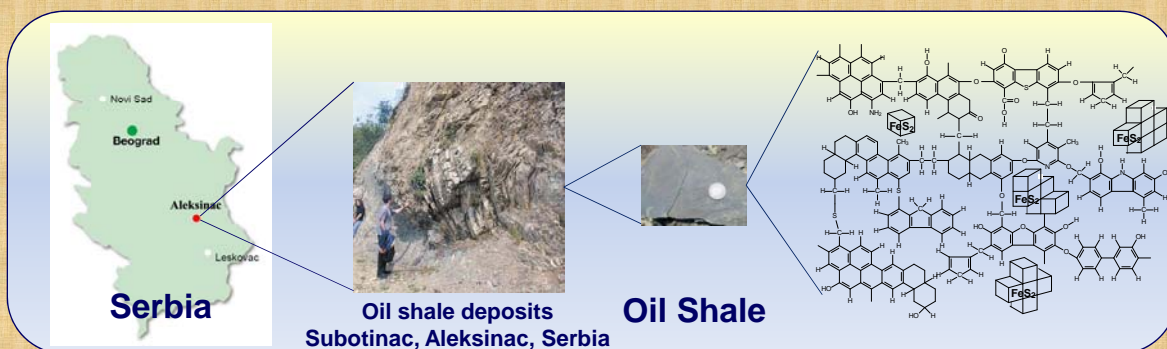
# REVIEW OF OUR BENEFICIATION OF OIL SHALE BY BIOPROCESSING ON LABORATORY SCALE

Miroslav M. VRVIĆ, Vladimir P. BEŠKOSKI\*, Olga CVETKOVIĆ\*, Vesna DRAGUTINOVIĆ\*\*, Valerija MATIĆ\*, Snežana SPASIĆ\*, Dragomir VITOROVIĆ\*\*\*

Faculty of Chemistry, University of Belgrade, P.O.Box 51, Belgrade, Serbia  
 \*Department of Chemistry IChTM, University of Belgrade, P.O.Box 473, Belgrade, Serbia  
 \*\*School of Medicine, University of Belgrade, Belgrade, Serbia  
 \*\*\*Serbian Academy of Science, Belgrade, Serbia  
 E-mail: mmvchem@sezampro.rs

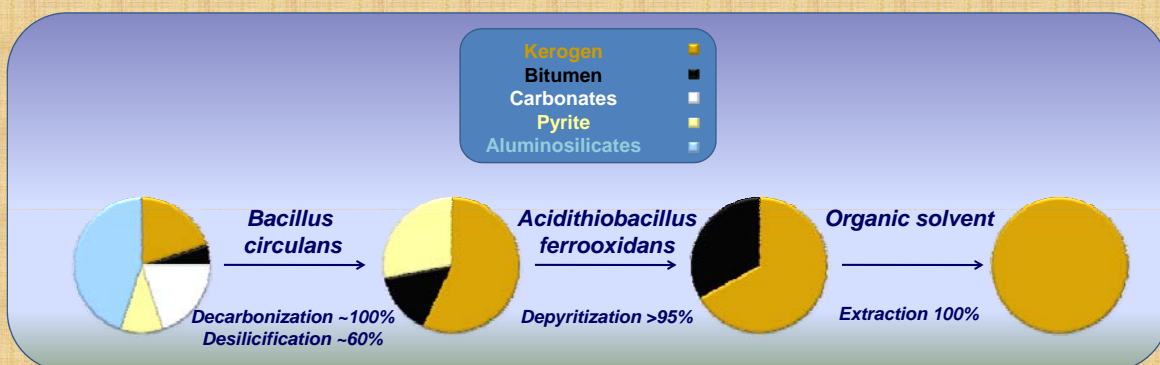
## INTRODUCTION

It is estimated that reserves of oil shale in Serbia amount to about **3 billion tons**, while the largest deposit (approx. 2/3 of total amount) for open-pit and underground exploitation is situated in the locality of Aleksinac in East Serbia. This deposit is not exploited at the moment. Shale from Aleksinac is an immature Oligocene-Miocene lacustrine sediment.



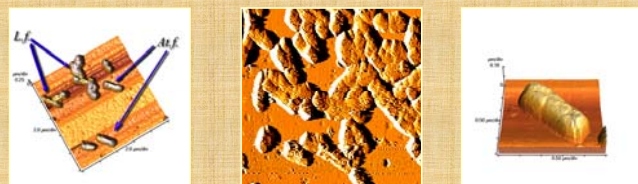
## RESULTS AND DISCUSSION

Our lab researches relating to the "quality improvement" of raw shale from Aleksinac that have been made for more than 25 years are primarily aimed at obtaining the structurally unchanged concentrate of **kerogen** for fundamental organic geochemical investigation, with the potential application, which has become more popular nowadays. As "non-destructive reagents" we use **microorganisms** that for the carbon source do not use the organic substance of oil shale as substrate[1-5].



By the removal of the organically bound sulphur, for the purpose of reducing the content of the total sulphur, primarily in order to reduce aero pollution, through an action of the bacterial generated iron(III)-ion from pyrite, with dibenzothiophene as the model substrate, the desulphurization is completed as well as the total biobeneficiation of oil shale [6,7].

Hemolytrophic acidophilic microbial strains in action on oil shale surface followed by **Atomic Force Microscopy (AFM)** [8].



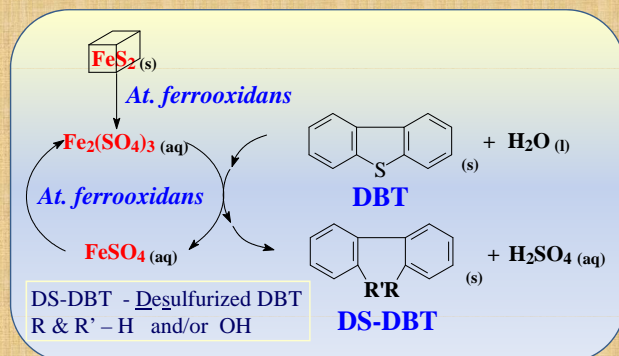
Mixed culture of *Acidithiobacillus ferrooxidans* and *Leptospirillum ferrooxidans*

Pure culture of *At. ferrooxidans*

*At. ferrooxidans*

## CONCLUSION

**The way to the application of microbial-bio(geo)technological methods for the purpose of obtaining oil shale of the improved quality as the source of energy and as an alternative liquid hydrocarbon fuel is long and hard, but certainly that should persist on it and work pursue to this goal with dedication and zeal.**



## REFERENCES

1. M.M.Vrvić, V.Matić, J.Vučetić, D.Vitorović, Demineralization of an oil shale by *Bacillus circulans* ("siliceous bacteria"), *Org. Geochem.* **16** (4-6) (1990) 1203-1209
2. M.M.Vrvić, V.Djordjević, D.Savković, J.Vučetić, D. Vitorović, Preparation of rich kerogen concentrates: removal of pyrite with *Thiobacillus ferrooxidans*, *Org. Geochem.* **13** (1988) 1109-1114
3. O.Cvetković, V.Dragutinović, M.M.Vrvić, J.A.Curiale, M.Ercegovac, D.Vitorović, Evidence of stable kerogen composition during bacterial depyritization of an oil shale, *Org. Geochem.* **20** (1993) 57-68
4. M.M.Vrvić, V.Dragutinović, V.Matić, S.Spasić, O.Cvetković, D.Vitorović, A kinetic study of the depyritization of oil shale HCl-kerogen concentrate by *Thiobacillus ferrooxidans* at different temperatures, *J. Serb. Chem. Soc.* **68** (4-5) (2003) 417-423
5. O. Cvetković, M.M.Vrvić, V.Dragutinović, D.Vitorović, Preparation of sedimentary organic matter concentrates by microbiological methods, *Microbiology-Belgrade* **43** (1) (2006) 41-54
6. V.P.Beškosi, V.Matić, J. Milić, D.Godjevac, B.Mandić, M.M.Vrvić, Oxidation of dibenzothiophene as model substrate for removal of organic sulphur from fossil fuels by iron(III)-ion generated from pyrite by *Acidithiobacillus ferrooxidans*, *J. Serb. Chem. Soc.* **72** (6) (2007) 533-537
7. V.P.Beškosi, J. Milić, B.Mandić, M.Takić, M.M.Vrvić, Removal of organically bound sulfur from oil shale by iron(III)-ion generated-regenerated from pyrite by the action of *Acidithiobacillus ferrooxidans* — Research on a model system, *Hydrometallurgy* **94** (2008) 8-13
8. J.S.Milić, V.P.Beškosi, D.V.Randjelović, M.M.Vrvić, Characterization of hemolytrophic acidophilic microbial strains attaching affinity on oil shale surface followed by atomic force microscopy (AFM), *Abstract Book of the 2nd FEMS Congress of European Microbiologists*, Madrid (Spain), 2006, p. 170.