HEAVY CRUDE AND TAR SANDS
– HYDROCARBONS
FOR THE 21ST CENTURY

VOLUME 1
GEOLOGY, CHARACTERIZATION AND MINING
CONTENTS

VOLUME 1 — GEOLOGY, CHARACTERIZATION AND MINING

PUBLISHER’S NOTE ................................................................. iii
CONTENTS ....................................................................................... ix
PREFACE ....................................................................................... xiii
ACKNOWLEDGEMENTS .............................................................. xiv
ORGANIZING COMMITTEE .......................................................... xv
FOREWORD ................................................................................... xvii
INTRODUCTION ............................................................................ xix

CHARACTERIZATION OF BITUMENS AND HEAVY CRUDES

A MIXING RULE FOR THE VISCOSITY OF COLD LAKE BITUMEN AND ITS FRACTIONS
DILUTED WITH GASES AND TOLUENE
Anil K. Mehrotra (Canada) ............................................................... 3

CHEMICAL CHARACTERIZATION OF ALBERTA OIL SAND BITUMEN
Otto P. Strausz, Elizabeth M. Lown and Thomas W. Mojelsky (Canada) ............................................................... 13

THERMAL PROPERTIES OF HEAVY OIL SANDS IN TRINIDAD
Dr. L.N.S. Kunar and Ms. Shazeeda Hosein (Trinidad, West Indies) ............................................................... 27

SEPARATION OF OIL FROM OIL-IN-WATER EMULSIONS BY A FLOTATION COLUMN
Rajindar Pal and Jacob Masliyah (Canada) ......................................................... 39

EFFECTS OF GAS COMPONENTS ON THERMODYNAMIC PROPERTIES OF ALBERTA HEAVY CRUDES AND BITUMENS
Ding-Yu Peng, Cheng-Tze Fu, Gordon W. Bird and Chu Hsi (Canada) ............................................................... 47

X-RAY FLUORESCENCE DETERMINATION OF Si IN HEAVY OILS
M. Hernández, P. Díaz and M. Carrillo (Venezuela) ......................................................... 57

CHARACTERIZATION OF BITUMENS, HEAVY CRUDES AND VACUUM RESIDUA: A REVIEW
A. Izquierdo, L. Carbognani and A. Méndez (Venezuela) ......................................................... 65

A BRIEF REVIEW OF THE OPTICAL CHARACTERISTICS OF SOME CANADIAN NATURAL BITUMENS
Thomas Gentsis and Fariborz Goodarzi (Canada) ......................................................... 85

EVALUATION OF VENEZUELAN BITUMENS AND ASPHALTS
Carlo Giavarini, Giuseppe Giannetto, Maria Esther Hernandez Achile Mascherpa and Carmen Vecchi (Italy) ......................................................... 93

CHARACTERIZATION OF STRONGLY BOUNDED ORGANIC MATTER PRESENT IN
ATHABASCA OIL SANDS USING A COMBINATION OF ALKALINE AND SUPERCritical
FLUID EXTRACTIONS
L.S. Kotlyar, J.A. Ripmeester, B.D. Sparks and J.R Woods (Canada) ......................................................... 97
THE POLARITY OF BIODEGRATED CRUDES
Indi M.R. de Andrade Brüning (Brazil) .................................................. 103

APPLICATION OF ASPHALTENE PYROLYSIS TO THE CHARACTERIZATION OF DEGRADED CRUDE OILS
Louis W. Elrod (USA) ........................................................................... 111

FUNDAMENTALS OF ASPHALTENE PRECIPITATION IN HEAVY OIL AND TAR SANDS (ABSTRACT)
Norman F. Carnahan (USA) ................................................................. 127

RHEOLOGY OF HEAVY OIL AND HEAVY OIL MIXTURES (ABSTRACT)
Norman F. Carnahan (USA) ................................................................. 129

SOLUTION THEORY MODEL FOR PHASE BEHAVIOR IN HEAVY OILS (ABSTRACT)
Norman F. Carnahan (USA) ................................................................. 131

EXPLORATION

ASSESSING THE NEED OF APPLYING GEOCHEMICAL TECHNIQUES FOR THE OPTIMUM EXPLOITATION OF TAR SANDS OF THE ORINOCO BELT
Decio Flores (Venezuela) ................................................................... 135

EXPLOITATION PROSPECTS FOR OUTCROP DEPOSIT IN SOUTHERN TRINIDAD
Harry Kuarsingh and Utam S. Maharaj (Trinidad and Tobago, W.J.) ................... 141

DEVELOPMENT AND APPLICATION OF HIGH RESOLUTION SEISMIC FOR OIL SANDS EXPLORATION AND DEVELOPMENT
G.Hawes and J. Henderson (Canada) ...................................................... 155

TRACE METALS IN PETROLEUM EXPLORATION — THEIR DETECTION, QUANTITATIVE ESTIMATION, SEPARATION AND SIGNIFICANCE
T.N.V. Raghavan and Y.K. Agrawal (India) ............................................... 169

CHEMISTRY AND MINERALOGY OF SELECTED HEAVY OILS, NATURAL BITUMENS, AND THEIR RESERVOIR ROCKS
John W. Hosterman, Richard F. Meyer, Curtis A. Palmer and Michael W. Doughton (USA) ........................................... 193

METAL BEARING HEAVY OILS AND NATURAL BITUMEN DISTRIBUTION REGULARITIES AND PROGNOSIS OF THEIR ACCUMULATION ZONES
Iosif S. Goldberg (USSR) .................................................................... 211

GEOLOGY AND RESOURCES

A NUMERICAL MODEL TO PREDICT THE COMPOSITION OF HYDROCARBONS (HEAVY OIL, LIGHT OIL, GAS) EXPELLED FROM SOURCE-ROCKS ON THE BASIN SCALE
B. Durand and P.Y. Chenet (France) ...................................................... 223

SIMULATION TO ASSESS THE EFFECTS OF GEOLOGY ON CYCLIC STEAM OPERATIONS IN ATHABASCA
G.S. Sarioglu and M.Y. Chang (Canada) .................................................. 235

R.G. Chalcraft (USA) W.R. Cox (Canada) ............................................... 245
# TABLE OF CONTENTS

## A DESCRIPTION OF THE JINGLOU ANTICLINAL RESERVOIR IN THE HENAN OIL FIELD
— THE APPLICATION OF FUZZY MATHEMATICS IN RESERVOIR DESCRIPTION

*Wang Jixian and Lin Chunzeng (P.R. of China)* 259

## McMURRAY FORMATION AND WABISKAW MEMBER (CLEARWATER FORMATION): REGIONAL PERSPECTIVES DERIVED FROM THE NORTH PRIMROSE AREA, ALBERTA, CANADA

*Daryl M. Wightman, Joseph R. MacGillivray, D. McPhee, H. Berhane and T. Berezniuk (Canada)* 285

## GEOLOGY OF THE EXPERIMENTAL PRODUCTION PROJECT BEP 0–16 CERRO NEGRO AREA, ORINOCO BELT

*Antonio Santos C. (Venezuela)* 321

## BEMOLANGA AND TSIMIRORO SOURCE ROCKS AND HYDROCARBON GENERATION

*E. Raveloson, J. Ranasy, Sparihariaona and L. Ramanampisoa (Madagascar)* 357

## THE GEOLOGY OF THE NIGERIAN TAR SANDS

*O.S. Adegoke, M.E. Omatola and S.E.L. Coker (Nigeria)* 369

### RESOURCE CHARACTERIZATION

## CHARACTERISTICS AND POTENTIAL OF U.S. HEAVY OIL

*Michael L. Godec (USA)* 389

## ASBUTON RESOURCES ON BUTON ISLAND, INDONESIA

*J.W. Kramers and S.K. Chakrabartty (Canada) S. Supriyadi and I. Darmawan (Indonesia)* 397

## NATURE OF IRANIAN BITUMEN AND HEAVY OIL

*F. Goodarzi (Canada)* 409

### BITUMEN MINING AND UTILIZATION

## CURRENT PRODUCTION PROBLEMS OF NATURAL BITUMENS AND BITUMINOUS ROCKS IN THE SOVIET UNION

*G.G. Vakhitov and L.I. Ferdman (USSR)* 423

## TECHNOLOGY OF THERMAL OIL MINING IS AN EFFECTIVE OIL RECOVERY METHOD

*Vladimir Pavlovitch Tabakov, Yevgeniy Ivanovitch Gurov, Boris Aleksandrovitch Tyunkin, Gennadiy Ilyitch Vakhnin (USSR)* 427

## AN EVALUATION OF THE MINEABLE TAR SANDS, TRINIDAD, WEST INDIES

*W.T. Rajpaulousingh and L.N.S. Kunar (Trinidad)* 437

## DREDGING OF OVERBURDEN AND ORE MINING FOR TAR SAND DEPOSITS

*J. M. Waring (Canada) G.H. van Raalte and G. van Staal (Netherlands)* 443

## NATURAL BITUMINOUS ROCKS FOR MOTOR ROAD CONSTRUCTION IN MONGOLIAN REPUBLIC

*Strelnikova Vera and Kolesnikov Boris (USSR)* 451

## SECONDARY PRODUCT POTENTIAL OF OIL SANDS OPERATIONS

*Ian C. Webster (Canada)* 457

## NEW APPROACH TO SHALLOW OIL RECOVERY MEMBRANE-LIKE-MATERIAL

*James Keane (USA)* 467
EXTRACTION AND PRODUCTION OF ASPHALT FROM UTAH TAR SANDS
James W. Bunger, Jerry W. Wiser, Prasad A.V. Devineni and C.P. Russell (USA) ................................................................. 481

AOSTRA'S UNDERGROUND TEST FACILITY (UTF) IN THE ATHABASCA OIL SANDS OF ALBERTA
J.C. O'Rourke, C.G. Bohme, N.R. Edmunds, J.A. Kovalsky, R.W. Luhning and J.C. Suggett (Canada) ........ 487

DEVELOPMENT PROSPECTS FOR THE BITUMINOUS DEPOSITS IN NIGERIA
R.D. Adelu and E.A. Fayose (Nigeria) .......................................................................................................................... 509

AUTHOR INDEX ....................................................................................................................................................... 517