

ESCOLA UNIVERSITÀRIA POLITÈCNICA DE MANRESA

Departament d'Enginyeria Minera i Recursos Naturals

**ESTUDI DELS MARCADORS
BIOMARCADORS DE CONQUES
ALTAMENT REDUCTORES**

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- SINNINGHE DAMSTÉ, J.S. (1988) Organically-bound sulphur in the geosphere: A molecular approach. Tesi Doctoral, Delft Technische Universiteit.
- SINNINGHE DAMSTÉ, J.S. i DE LEEUW, J.W. (1987) The origin and fate of isoprenoid C₂₀ and C₂₅ sulphur compounds in sediments and oils. *Intern. J. Environ. Anal. Chem.* **28**, 1-19.
- SINNINGHE DAMSTÉ, J.S. i DE LEEUW, J.W. (1995) Comments on "Biomarkers or not biomarkers. A new hypothesis for the origin of pristane involving derivation from methyltrimethyldecylchromans (MTTCs) formed during diagenesis from chlorophyll and alkylphenols" from M. Li, S.R. Larter, P.Taylor, D.M. Jones, B. Bowler and Bjorøy. *Org. Geochem.* **23**, 1085-1087.
- SINNINGHE DAMSTÉ, J.S. i RIJSTRA, W.I.C. (1993) Identification of novel C₂₅ highly branched isoprenoid thiophene in sediments. *Org. Geochem.* **20**, 327-331.
- SINNINGHE DAMSTÉ, J.S. i SCHOUTEN, S. (1997) Is there evidence for a substantial contribution of prokaryotic biomass to organic carbon in Phanerozoic carbonaceous sediments?. *Org. Geochem.* **26**, 517-530.
- SINNINGHE DAMSTÉ, J.S., BETTS, S., LING, Y., HOFMANN, P. i DE LEEUW, J.W. (1993a) Hydrocarbon biomarkers of different lithofacies of the Salt IV formation of the Mulhouse Basin. France. *Org. Geochem.* **20**, 1187-1200.
- SINNINGHE DAMSTÉ, J.S., DE LAS HERAS, F.X. i DE LEEUW, J.W. (1992) Molecular Analysis of Sulfur-Rich Brown Coals by Flash Pyrolysis Gas Chromatography Mass Spectrometry. The Type III-S Kerogen. *J. Chromatogr.* **607**, 361-376.
- SINNINGHE DAMSTÉ, J.S., DE LAS HERAS, F.X., VAN BERGEN, P.F. i DE LEEUW, J.W. (1993b) Characterization of Tertiary Catalan lacustrine oils shales: Discovery of extremely organic sulphur-rich Type I kerogens. *Geochim. Cosmochim. Acta* **57**, 389-415.
- SINNINGHE DAMSTÉ, J.S., DE LEEUW, J.W., KOCK VAN DALEN, A.C., DE ZEEUW, M.A., DE LANGE, F., RIJSTRA, W.I.C. i SCHENCK, P.A. (1987a) The occurrence and identification of series of organic sulphur compounds in oils and sediment extracts. I. A study of Rozel Point (USA). *Geochim. Cosmochim. Acta* **51**, 2369-2391.
- SINNINGHE DAMSTÉ, J.S., KEELY, B.J., BETTS, S.E., BAAS, M., MAXWELL, J.R. i DE LEEUW, J.W. (1993c) Variations in abundance and distributions of isoprenoid chromans and long chain alkylbenzenes in sediments of the Mulhouse Basin: a molecular sedimentary record of paleosalinity. *Org. Geochem.* **20**, 1201-1215.
- SINNINGHE DAMSTÉ, J.S., KENIG, F., KOOPMANS, M.P., KÖSTER, J., SCHOUTEN, S., HAYES, J.M. i DE LEEUW, J.W. (1995a) Evidence for

- gammacerane as an indicator of water column stratification. *Geochim. Cosmochim. Acta* **59**, 1895-1900.
- SINNINGHE DAMSTÉ, J.S., KOCK VAN DALEN, A.C., DE LEEUW, J.W., SCHENCK, P.A., GUOYING, S. i BRASSELL, S.C. (1987b) The identification of mono, di and trimethyl 2-methyl-2-(4,8,12-trimethyltridecyl)chromans and their occurrence in the geosphere. *Geochim. Cosmochim. Acta* **51**, 2393-2400.
- SINNINGHE DAMSTÉ, J.S., KOOPMANS, M.P., KÖSTER, J., VAN KAAMPETERS, H.M.E., KENIG, F., SCHOUTEN, S. i DE LEEUW, J.W. (1995b) Molecular indicators of palaeoenvironmental change in a Messinian evaporitic sequence (Vena del Gesso, Italy). *Organic Geochemistry: Developments and Applications to Energy, Climate, Environment and Human History*. 17th International Meeting on Organic Geochemistry, San Sebastián, Spain, 4-8 September, 1995. Abstracts, eds J. Grimalt i C. Dorronsoro, pp. 113-115. A.I.G.O.A., Donostia-San Sebastián, Espanya.
- SINNINGHE DAMSTÉ, J.S., KOOPMANS, M.P., KÖSTER, J., VAN KAAMPETERS, H.M.E., KENIG, F., SCHOUTEN, S. i DE LEEUW, J.W. (1995c) Molecular palaeontological evidence for photic zone anoxia in past depositional environments. *Organic Geochemistry: Developments and Applications to Energy, Climate, Environment and Human History*. 17th International Meeting on Organic Geochemistry, San Sebastián, Spain, 4-8 September, 1995. Abstracts, eds J. Grimalt i C. Dorronsoro, pp. 55-57. A.I.G.O.A., Donostia-San Sebastián, Espanya.
- SINNINGHE DAMSTÉ, J.S., RIJPSRA, W.I.C., DE LEEUW, J.W. i SCHENCK, P.A. (1988) Origin of organic sulphur compounds and sulphur containing high molecular weight substances in sediments and immature crude oils. *Org. Geochem.* **13**, 593-606.
- SINNINGHE DAMSTÉ, J.S., RIJPSRA, W.I.C., DE LEEUW, J.W. i SCHENCK, P.A. (1989a) The occurrence and identification of series of organic sulfur compounds in oils and sediment extracts: II. Their presence in samples from hypersaline and non-hypersaline palaeoenvironments and possible application as source, palaeoenvironmental and maturity indicators. *Geochim. Cosmochim. Acta* **53**, 1323-1341.
- SINNINGHE DAMSTÉ, J.S., RIJPSRA, W.I.C., KOCK VAN DALEN, A.C., DE LEEUW, J.W. i SCHENCK, P.A. (1989c) Quenching of labile functionalised lipids by inorganic sulphur species: Evidence for the formation of sedimentary organic sulphur compounds at the early stage of diagenesis. *Geochim. Cosmochim. Acta* **58**, 1343-1355.
- SINNINGHE DAMSTÉ, J.S., RIJPSRA, W.I.C., SCHOUTEN, S., PELETIER, H., VAN DER MAAREL, M.J.E.C. i GIESKES, W.C. (1999) A C₂₅ highly branched isoprenoid alkene and C₂₅ and C₂₇ n-polyenes in the marine diatom *Rhizosolenia setigera*. *Org. Geochem.* **30**, 95-100.

- SINNINGHE DAMSTÉ, J.S., TEN HAVEN, H.L., DE LEEUW, J.W. i SCHENCK, P.A. (1986) Organic geochemical studies of a Messinian evaporitic basin, northern Apennines (Italy). II: isoprenoid and *n*-alkyl thiophenes and thiolanes. *Org. Geochem.* **10**, 791-805.
- SINNINGHE DAMSTÉ, J.S., VAN KOERT, E.R., KOCK-VAN DALEN, A.C., DE LEEUW, J.W. i SCHENCK, P.A. (1989b) Characterization of highly branched isoprenoid thiophenes occurring in sediments and immature crude oils. *Org. Geochem.* **14**, 555-567.
- SINNINGHE DAMSTÉ, J.S., WAKEHAM, S.G., KOHNEN, M.E.L., HAYES, J.M. i DE LEEUW, J.W. (1993d) A 6,000-year sedimentary molecular record of chemocline excursions in the Black Sea. *Nature* **362**, 827-829.
- SKERRATT, J.H., NICHOLS, P.D., BOWMAN, J.P. i SLY, L.I. (1992) Occurrence and significance of long-chain (ω -1)-hydroxy fatty acids in methane-utilizing bacteria. *Org. Geochem.* **18**, 189-194.
- SMITH, D.J., EGLINTON, G. i MORRIS, R.J. (1983) Occurrence of long chain alkandiolis and alkan-15-one-1-ols in a Quaternary Sapropel from the eastern Mediterranean. *Lipids* **18**, 902-905.
- SOKOLOVA, I.M., ABRYUTINA, N.N., PUNANOV, V.G. i PETROV, A.A. (1992) Chemical classification of naphthenic condensates and oils. *Org. Geochem.* **19**, 1-11.
- SOLÉ DE PORTA, N. i PORTA, J. (1979) Contribució a la palinologia del Oligoceno en la regió de Calaf (Barcelona). *Acta Geol. Hisp.* **14**, 351-353.
- SORM, F., VOLLRAB, V., JAROLIMEK, P. i STREIBL, M. (1964) Olefins in plant waxes. *Chem. Ind.*, 1833-1834.
- SOYLU, C. i PHILP, R.P. (1991) Petroleum geochemistry of the Adiyaman area oils, SE Turkey. A *Organic Geochemistry: Advances and Applications in Energy and the Natural Environment*. 15th International Meeting of the European Association of Organic Geochemistry, Manchester, England, September, 1991. Poster Abstracts, eds David Manning, pp. 114-116. A.I.G.O.A., Manchester University Press, Manchester.
- STANIER, R.Y., INGRAHAM, J.L., WHEELIS, M.L. i PAINTER, P.R. (1988) *Microbiologia*. Ed. Reverté, S.A., 2^a edició, 491-494. Barcelona.
- STAMPF, P., HERMANN, D., BISSERET, P. i ROHMER, M. (1991) 2 α -Methylhopanoids: first recognition in the bacterium *Methylobacterium organophilum* and obtention via sulphur isomerization of 2 β -methylhopanoids. An account for their presence in sediments. *Tetrahedron* **47**, 7081-7090.
- STEFANOVA, M., MAGNIER, C. i VELINOVA, D. (1995) Biomarker assemblage of some Miocene-aged Bulgarian lignite lithotypes. *Org. Geochem.* **23**, 1067-1084.

- STODOLA, F.H., DEINEMA, M.H. i SPENCER, J.F.T. (1967) Extracellular lipids of yeasts. *Bacteriol. Rev.* **31**, 194-213.
- SUMMONS, R.E. i CAPON, R.J. (1988) Fossil steranes with unprecedented methylation in ring-A. *Geochim. Cosmochim. Acta* **52**, 2733-2736.
- SUMMONS, R.E. i CAPON, R.J. (1991) Identification and significance of 3 β -ethyl steranes in sediments and petroleum. *Geochim. Cosmochim. Acta* **55**, 2391-2395.
- SUMMONS, R.E. i JAHNKE, L.L. (1990) Identification of the methylhopanes in sediments and petroleum. *Geochim. Cosmochim. Acta* **54**, 247-251.
- SUMMONS, R.E. i POWELL, T.G. (1987) Identification of aryl isoprenoids in source rocks and crude oils: Biological markers for the green sulphur bacteria. *Geochim. Cosmochim. Acta* **51**, 557-566.
- SUMMONS, R.E., BARROW, R.A., CAPON, R.J., HOPE, J.M. i STRANGER, C. (1993) The structure of a new C₂₅ isoprenoid alkene biomarker from diatomaceous microbial communities. *Australian J. Chem.* **46**, 907-915.
- SUMMONS, R.E., BRASSELL, S.C., EGLINTON, G., EVANS, E., HORODYSKI, R.J., ROBINSON, N. i WARD, D.M. (1988b) Distinctive hydrocarbon biomarkers from fossiliferous sediment of the Late Proterozoic Walcott Member, Chuar Group Grand Canyon, Arizona. *Geochim. Cosmochim. Acta* **52**, 2625-2637.
- SUMMONS, R.E., JAHNKE, L.L. i ROKSANDIC, Z. (1994) Carbon isotopic fractionation in lipids from methanotrophic bacteria: Relevance for interpretation of the geochemical record of biomarkers. *Geochim. Cosmochim. Acta* **58** 2853-2863.
- SUMMONS, R.E., POWELL, T.G. i BOREHAM, C.J. (1988a) Petroleum geology and geochemistry of the Middle Proterozoic McArthur Basin, Northern Australia III. Composition of extractable hydrocarbons. *Geochim. Cosmochim. Acta* **52**, 1747-1763.
- SWEENEY, J.J., BURNHAM, A.K. i BRAUN, R.L. (1987) A model of hydrocarbon generation from type I kerogen: Application to Uinta Basin: Utah. *A.A.P.G. Bull.* **71**, 967-985.
- TALUKDAR, S., GALLANGO, O. i CHIN-A-LIEN, M. (1986) Generation and migration of hydrocarbons in the Maracaibo Basin, Venezuela: An integrated basin study. *Org. Geochem.* **10**, 261-279.
- TANAKA, R., SENBA, H., MINEMATSU, T., MURAOKA, O. i MATSUNAGA, S. (1995) 21 α -Hydroxy-3 β -methoxyserrat-14-en-30-al and other triterpenoids from the cuticle of *Picea jezoensis*. *Phytochem.* **38**, 1467-1471.

- TEGELAAR, E.W., MATTHEZING, R.M., JANSEN, J.B.H., HORSFIELD, B. i DE LEEUW, J.W. (1989) Possible origin of n-alkanes in high-wax crude oils. *Nature* **342**, 529-531.
- TEIXIDOR, P. (1996) Biogeoquímica d'alquilglicerols i altres lípids en sistemes deposicionals hipersalins. Tesi Doctoral, Universitat de Barcelona.
- TEIXIDOR, P., GARCÍA-VEIGAS, J., PUEYO, J.J. i GRIMALT, J.O. (1993) Lipids composition in Messinian halites from Lorca Basin (SE Iberian Peninsula). A *Organic Geochemistry. Poster Sessions from the 16th International Meeting on Organic Geochemistry*, Stavanger, Noruega, 22-24 September, 1993 (Editat per Øygard K.), pp. 554-557. Falch Hurtigtrykk, Oslo.
- TEN HAVEN, H.L. (1986) Organic and inorganic geochemical aspects of mediterranean Late Quaternary sapropels and Messinian evaporitic deposits. Ph. D. Thesis. University of Delft.
- TEN HAVEN, H.L., BAAS, M., DE LEEUW, J.W. i SCHENK, P.A. (1985) Organic geochemical studies of a Messinian evaporitic basin, northern Apennines (Italy) I: Hydrocarbon biological markers for a hypersaline environment. *Geochim. Cosmochim. Acta* **49**, 2181-2191.
- TEN HAVEN, H.L., BAAS, M., DE LEEUW, J.W. i SCHENK, P.A. (1987a) Late Quaternary Mediterranean sapropels-I. On the origin of organic matter in Sapropel S₇. *Mar. Geol.* **75**, 137-156.
- TEN HAVEN, H.L., BAAS, M., DE LEEUW, J.W., SCHENK, P.A. i BRINKHUIS, H. (1987b) Late Quaternary Mediterranean sapropels-II. Organic geochemistry and palynology of S₁ sapropels and associated sediments. *Chem. Geol.* **64**, 149-167.
- TEN HAVEN, H.L., BAAS, M., KROOT, M., DE LEEUW, J.W., SCHENK, P.A. i EBBING, J. (1987c) Late Quaternary Mediterranean sapropels-III. Assessment of source of input and palaeotemperature as derived from biological markers. *Geochim. Cosmochim. Acta* **51**, 803-810.
- TEN HAVEN, H.L., DE LEEUW, J.W. i SCHENCK, P.A. (1985) Organic geochemical studies of a Messinian evaporitic basin, Northern Apennines (Italy) I: hydrocarbon biological markers for a hypersaline environment. *Geochim. Cosmochim. Acta* **49**, 2181-2191.
- TEN HAVEN, H.L., DE LEEUW, J.W., PEAKMAN, T.M. i MAXWELL, J.R. (1986) Anomalies in steroid and hopanoids maturity indices. *Geochim. Cosmochim. Acta* **50**, 853-855.
- TEN HAVEN, H.L., DE LEEUW, J.W., RULLKÖTTER, J. i SINNINGHE DAMSTÉ, J.S. (1987d) Restricted utility of the pristane/phytane ratio as a palaeo-environmental indicator. *Nature* **330**, 641-643.

- TEN HAVEN, H.L., PEAKMAN, T.M. i RULLKÖTTER, J. (1992) Early Diagenetic Transformation of Higher-Plant Triterpenoids in Deep-Sea Sediments from Baffin-Bay. *Geochim. Cosmochim. Acta* **56**, 2001-2024.
- TEN HAVEN, H.L., ROHMER, M., RULLKÖTTER, J. i BISSERET, P. (1989) Tetrahymanol, the most likely precursor of gammacerane, occurs ubiquitously in marine sediments. *Geochim. Cosmochim. Acta* **53**, 3073-3079.
- TENZER, G.E., MEYERS, P.A., ROBBINS, J.A., EADIE, B.J., MOREHEAD, N.R. i LANSING, M.B. (1999) Sedimentary organic matter record of recent environmental changes in the St. Marys River ecosystem, Michigan-Ontario border. *Org. Geochem.* **30**, 133-146.
- THIEL, V., JENISCH, A., WÖRHEIDE, G., LÖWENBERG, A., REITNER, J. i MICHAELIS, W. (1999) Mid-chain branched alkanolic acids from "living fossil" demosponges: a link to ancient sedimentary lipids?. *Org. Geochem.* **30**, 1-14.
- TISSOT, B.P. i WELTE, D.H. (1984) *Petroleum Formation and Occurrence*. 2nd Ed. 699 pàgs. Springer-Verlag, Heidelberg.
- TISSOT, B., CALIFET-DEBYSER, Y., DEROO G. i OUDIN, J.L. (1971) Origin and evolution of hydrocarbons in Early Toarcian shales, Paris Basin, France. *A.A.P.G. Bull.* **55**, 2177-2193.
- TISSOT, B.P., DEROO, G. i HOOD, A. (1978) Geochemical study of the Uinta Basin: Formation of petroleum from the Green River Formation. *Geochim. Cosmochim. Acta* **42**, 1469-1485.
- TISSOT, B.P., PELET, R. i UNGERER, P. (1987) Thermal history of sedimentary basins, maturation indices, and kinetics of oil and gas generation. *A.A.P.G. Bull.* **71**, 1445-1466.
- TOBIAS, P.V. (1999) Commentary on the case for Early Pleistocene Hominids in South-Eastern Spain. *The Hominids and their Environment during the Lower and Middle Pleistocene of Eurasia*. Proceedings of the International Conference of Human Palaeontology, Orce 1995. Editat per: J. Gibert, F. Sánchez, L. Gibert i F. Ribot, pp. 39-44. Museo de Prehistoria y Paleontologia "J. Gibert". Ayuntamiento de Orce.
- TOMIC, J., BEHAR, F., VANDERBROUCKE, M. i TANG, Y. (1995) Artificial maturation of Monterey kerogen (Type II-S) in a closed system and comparison with Type II kerogen: implications on the fate of sulfur. *Org. Geochem.* **23**, 647-660.
- TRICHET, J. i FIKRI, A. (1997) Organic matter in the genesis of High-Island atoll peloidal phosphorites: the lagoonal link. *J. Sedimen. Res.* **67**, 891-897.
- TULLOCH, A.P. (1976) Chemistry of waxes of higher plants. A "Chemistry and biochemistry of natural waxes". (Eds. Kolattukudy) 236-289. Elsevier.

- TULLOCH, A.P. (1987) Epicuticular waxes of *Abies balsamea* and *Picea glauca*: occurrence of long-chain methyl esters. *Phytochem.* **26**, 1041-1043.
- TULLOCH, A.P. i BERGTER, L. (1981) Epicuticular wax of *Juniperus scopulorum*. *Phytochem.* **20**, 12711-2716.
- TULLOCH, A.P., SPENCER, J.F.T. i GORIN, P.A.J. (1962) The fermentation of long chain compounds by *Turolopsis magnoliae*. *Can. J. Chem.* **40**, 1326-1338.
- TYSON, R.V. (1995) Sedimentary Organic Matter. Organic facies and palynofacies. Chapman & Hall, primera edició. London.
- UNGERER, P. (1990) State of art research in kinetic modelling of oil formation and expulsion. *Org. Geochem.* **16**, 1-25.
- UTRILLA, R. (1989) Les composicions isotòpiques ($\delta^{18}\text{O}$, $\delta^{34}\text{S}$) del sulfat, com a indicadors de l'origen de les evaporites del Mesozoic i del Cenozoic de la Península Ibèrica i les Illes Balears. Tesi Doctoral. Universitat de Barcelona.
- VAIRAVAMURTHY, A. i MOPPER, K. (1987) Geochemical formation of organosulphur compounds (thiols) by addition of H_2S to sedimentary organic matter. *Nature* **329**, 623-625.
- VAIRAVAMURTHY, A. i SCHOONEN, M.A.A. (1995) Geochemical Transformations of Sedimentary Sulfur: An Introduction. *Geochemical Transformations of Sedimentary Sulfur*. (Eds. Eglinton, T.I., Luther III, G.W. i Manowitz) 1-14. *Am. Chem. Soc.*, Washington.
- VAIRAVAMURTHY, M.A., MANOWITZ, B., MALETIC, D. i WOLFE, H. (1997) Interactions of thiols with sedimentary particulate phase: studies of 3-mercaptopropionate in salt marsh sediments from Shelter Island, New York. *Org. Geochem.* **26**, 577-585.
- VALISOLALAO, J., PERAKIS, N., CHAPPE, B. i ALBRECHT, P. (1984) A novel sulfur containing C_{35} hopanoid in sediments. *Tetrahedron Lett.* **25**, 1185-1186.
- VAN DER LINDEN, A.C. i THIJSSSE, G.J.E. (1965) The mechanism of microbial oxidation of petroleum hydrocarbons. *Adv. Enzymol.* **27**, 469-546.
- VAN DER SMISSEN, J.H., RULLKÖTTER, J. i PARTY, S. (1995) Organic geochemical characteristics of sediments from the continental margin off New Jersey. *A Organic Geochemistry: Developments and Applications to Energy, Climate, Environment and Human History*. 17th International Meeting on Organic Geochemistry, San Sebastián, Spain, 4-8 September, 1995. Abstracts, eds J. Grimalt i C. Dorronsoro, pp. 180-182. A.I.G.O.A., Donostia-San Sebastián, Espanya.
- VAN DORSSELAER, A (1974) Triterpènes des sediments. Ph. D. Thesis. Université Louis Pasteur, Estrasbourg.

- VAN GRAAS, G.W. (1990) Biomarker maturity parameters for high maturities: calibration of working range up to the oil/condensate threshold. *Org. Geochem.* **16**, 1025-1032.
- VAN KAAM-PETERS, H.M.E., KÖSTER, J., DE LEEUW, J.W. i SINNINGHE-DAMSTÉ, J.S. (1995) Occurrence of two novel benzothiophene hopanoid families in sediments. *Org. Geochem.* **23**, 607-616.
- VAN KAAM-PETERS, H.M.E., KÖSTER, J., VAN DER GAAST, S.J., DEKKER, M., DE LEEUW, J.W. i SINNINGHE DAMSTÉ, J.S. (1999) The effect of clay minerals on diasterane/sterane ratios. *Geochim. Cosmochim. Acta* **62**, 2923-2929.
- VAN KAAM-PETERS, H.M.E., RIJPSTRA, W.I.C., DE LEEUW, J.W. i SINNINGHE-DAMSTÉ, J.S. (1998) A high resolution biomarker study of different lithofacies of organic sulfur-rich carbonate rocks of a Kimmeridgian lagoon (French southern Jura). *Org. Geochem.* **28**, 151-177.
- VAN LIER, J. E. i SMITH, L.L. (1970) Autooxidation of cholesterol via hydroperoxide intermediates. *J. Org. Chem.* **35**, 2627-2632.
- VENKATESAN, M.I. (1989) Tetrahymanol: Its widespread occurrence and geochemical significance. *Geochim. Cosmochim. Acta* **53**, 3095-3101.
- VERGÉS, J., MILLÁN, H., ROCA, E., MUÑOZ, J.A., MARZO, M., CIRÉS, J., DEN BEZEMER, T., ZOETEMEIJER, R. i CLOETINGH, S. (1995) Eastern Pyrenees and related foreland basins: pre-, syn- and post-collisional crustal-scale cross-sections. *Mar. Petrol. Geol.* **12**, 893-915.
- VERSTEEGH, G.J.M., BOSCH, H.J., JANSEN, J.H.F., MÜLLER, P.J., SCHNEIDER, R.R. i DE LEEUW, J.W. (1997a) Long-chain diols, keto-ols and hydroxy fatty acids as palaeoenvironmental tools to trace oceanic-front variations in the SE-Atlantic. A *Organic Geochemistry*. 18th International Meeting on Organic Geochemistry, Maastricht, The Netherlands, 22-26 September, 1997. Abstracts Part II, pp. 673-674. Forschungszentrum Jülich, Alemanya.
- VERSTEEGH, G.J.M., BOSCH, H.J. i DE LEEUW, J.W. (1997b) Potential palaeoenvironmental information of C₂₄ to C₃₆ mid-chain diols, keto-ols and mid-chain hydroxy fatty acids; a critical review. *Org. Geochem.* **27**, 1-13.
- VILLAR, H., PÜTTMAN, W. i WOLF, M. (1988) Organic geochemistry and petrography of Tertiary coals and carbonaceous shales from Argentina. *Org. Geochem.* **13**, 1011-1021.
- VINK, A., SCHOUTEN, S. i SINNINGHE DAMSTÉ, J.S. (1997) Unusual isoprenoidal carbon skeletons in the lower Albian Niveau Paquier black shale (Vocontian Basin; SE France). A *Organic Geochemistry*. 18th International Meeting on Organic Geochemistry, Maastricht, The Netherlands, 22-26 September, 1997. Abstracts Part II, pp. 661-662. Forschungszentrum Jülich, Alemanya.

- VIOQUE, J., PASTOR, J. i VIOQUE, E. (1994) Leaf wax alkanes in the genus *Coincya*. *Phytochem.* **36**, 349-352.
- VISO, A.C., PESANDO, D., BERNARD, P. i MARTY, J.C. (1993) Lipid components of the Mediterranean seagrass *Posidonia oceanica*. *Phytochem.* **34**, 381-387.
- VOLKMAN, J.K. (1986) A review of sterol markers for marine and terrigenous organic matter. *Org. Geochem.* **9**, 83-99.
- VOLKMAN, J.K. i HALLEGRAEFF, G.M. (1988) Lipids in marine diatoms of the genus *Thalassiosira*: Predominance of 24-methylenecholesterol. *Phytochem.* **27**, 1389-1394.
- VOLKMAN, J.K. i JOHNS, R.B. (1977) The geochemical significance of positional isomers of unsaturated acids from an intertidal zone sediment. *Nature* **267**, 693-694.
- VOLKMAN, J.K. i MAXWELL, J.R. (1986) Acyclic isoprenoids as biological markers. A "Biological markers in the sedimentary record" (Eds. R.B.Johns) 1-42. Elsevier, Amsterdam.
- VOLKMAN, J.K., BARRETT, S.M. i DUNSTAN, G.A. (1994a) C₂₅ and C₃₀ branched isoprenoid alkenes in laboratory cultures of two marine diatoms. *Org. Geochem.* **21**, 407-413.
- VOLKMAN, J.K., BARRETT, S.M., DUNSTAN, G.A. i JEFFEREY, S.W. (1992) C₃₀-C₃₂ alkandriols and unsaturated alcohols in microalgae of the Eustigmatophyceae. *Org. Geochem.* **18**, 131-138.
- VOLKMAN, J.K., BARRETT, S.M. i BLACKBURN, S.I. (1999) Eustigmatophyte microalgae are potential sources of C₂₉ sterols, C₂₂-C₂₈ *n*-alcohols and C₂₈-C₃₂ *n*-alkyl diols in freshwater environments. *Org. Geochem.* **30**, 307-318.
- VOLKMAN, J.K., BARRETT, S.M., DUNSTAN, G.A. i JEFFREY, S.W. (1993) Geochemical significance of the occurrence of dinosterol and other 4-methyl sterols in a marine diatom. *Org. Geochem.* **20**, 7-15.
- VOLKMAN, J.K., BARRETT, S.M., BLACKBURN, S.I., MANSOUR, M.P., SIKES, E.L. i GELIN, F. (1998) Microbial biomarkers: A review of recent research developments. A *Advances in Organic Geochemistry 1997. Part II*. *Org. Geochem.* **29**, 1163-1179.
- VOLKMAN, J.K., BARRETT, S.M., BLACKBURN, S.I., SIKES, E.L. i GELIN, F. (1997) Recent developments in marine algal biomarkers. A *Organic Geochemistry*. 18th International Meeting on Organic Geochemistry, Maastricht, The Netherlands, 22-26 September, 1997. Abstracts Part I, pp. 125-126. Forschungszentrum Jülich, Alemnanya.

- VOLKMAN, J.K., BARRETT, S.M., DUNSTAN, G.A. i JEFFREY, S.W. (1994b) Sterol Biomarkers for Microalgae from the Green Algal Class Prasinophyceae. *Org. Geochem.* **21**, 1211-1218.
- VOLKMAN, J.K., EGLINTON, G., CORNER, E.D.S. i FORSBERG, T.E.V. (1980a) Long-chain alkenes and alkenones in the marine coccolithophorid *Emiliana huxleyi*. *Phytochem.* **19**, 2619-2622.
- VOLKMAN, J.K., FARRINGTON, J.W., GAGOSIAN, R.B. i WAKEHAM, S.G. (1983) Lipid composition of coastal marine sediments from the Peru upwelling region. *Adv. Org. Geochem.* 1981 (Eds. Bjorøy *et al.*) 228-240. Wiley & Sons.
- VOLKMAN, J.K., FARRINGTON, J.W. i GAGOSIAN, R. B. (1987) Marine and terrigenous lipids in coastal sediments from the Peru upwelling region at 15° S: sterols and triterpene alcohols. *Org. Geochem.* **11**, 463-477.
- VOLKMAN, J.K., GILLAN, F.T., JOHNS, R.B. i EGLINTON, G. (1981) Sources of neutral lipids in a temperate intertidal sediment. *Geochim. Cosmochim. Acta* **45**, 1817-1828.
- VOLKMAN, J.K., JOHNS, R.B., GILLAN, F.T., PERRY, G.J. i BAVOR, H.J. (1980b) Microbial lipids of an intertidal sediment I. Fatty acids and hydrocarbons. *Geochim. Cosmochim. Acta* **44**, 1133-1143.
- VOLKMAN, J.K., KEARNEY, P. i JEFFREY, S.W. (1990) A new source for 4-methyl sterols and 5 α (H)-stanols sediments: prymnesiophyte microalgae of genus *Pavlova*. *Org. Geochem.* **15**, 489-497.
- VOLKMAN, J.K., NEILL, G.P., BLACKMAN, A.J. i FRANZMANN, P.D. (1991) Unsaturated phytenyl glyceryl ethers lipids in halophilic archabacteria. *14th Intl. Meeting on Organic Geochemistry, Contribution No. 168. Paris, Sept. 18-22.*
- WAKEHAM, S. G. (1989) Reduction of stenols to estanols in particulate matter at oxic-anoxic boundaries in sea water. *Nature* **342**, 787-790.
- WAKEHAM, S. G. (1990) Algal and bacterial hydrocarbons in particulate material and interfacial sediment of the Cariaco Trench. *Geochim. Cosmochim. Acta* **54**, 1325-1336.
- WAKEHAM, S. G. i CANUEL, E.A. (1990) Fatty acid and sterols of particulate matter in a brackish and seasonally anoxic coastal salt pond. *Org. Geochem.* **16**, 703-713.
- WAKEHAM, S.G. i LEE, C. (1989) Organic geochemistry of particulate matter in the ocean: the role of particles in oceanic sedimentary cycles. *Org. Geochem.* **14**, 83-96.
- WAKEHAM, S.G., SCHAFFNER, C. i GIGER, W. (1980) Polycyclic aromatic hydrocarbons in recent lake sediments. II. Compounds derived from biogenic precursors during early diagenesis. *Geochim. Cosmochim. Acta* **44**, 415-429.

- WAKEHAM, S.G., SINNINGHE DAMSTÉ, J.S., KOHNEN, M.E.L. i DE LEEUW, J.W. (1995) Organic sulfur compounds during early diagenesis in Black Sea sediments. *Geochim. Cosmochim. Acta* **59**, 521-533.
- WALTON, T.J. i KOLATTUKUDY, P.E. (1972) Determination of the structure of cutin monomers by a novel depolymerization procedure and combined gas chromatography. *Biochem.* **11**, 1885-1897.
- WANG, S. i RULLKÖTTER, J. (1997) Neutral polar lipids in freshwater and alkaline lacustrine sediments of the Green River Formation, Wyoming, U.S.A. A *Organic Geochemistry*. 18th International Meeting on Organic Geochemistry, Maastricht, The Netherlands, 22-26 September, 1997. Abstracts Part I, pp. 255-256. Forschungszentrum Jülich, Alemanya.
- WANNIGAMA, G.P., VOLKMAN, J.K., GILLAN, F.T., NICHOLS, P.D. i JOHNS, R.B. (1981) A comparison of lipid components of the fresh and dead leaves and pneumatophores of the mangrove. *Avicennia marina*. *Phytochem.* **20**, 659-666.
- WAPLES, D.W. i MACHIARA, T. (1990) Application of sterane and triterpane biomarkers in petroleum exploration. *Bull. Canad. Petrol. Geol.* **38**, 357-380.
- WAPLES, D.W., HAUG, P. i WELTE, D.H. (1974) Occurrence of a regular C₂₅ isoprenoid hydrocarbon in Tertiary sediments representing a lagoonal type saline environment. *Geochim. Cosmochim. Acta* **38**, 381-387.
- WARTON, B., ALEXANDER, R. i KAGI, R.I. (1998) The effect of maturation on the distribution of monoethylalkanes in Late Cretaceous sedimentary rocks and crude oils from the Gippsland Basin, Australia. A *Advances in Organic Geochemistry 1997. Part I. Org. Geochem.* **29**, 593-604.
- WEETE, J.D. (1976) Algal and fungal waxes. A *Chemistry and Biochemistry of Natural Waxes* (de. P.E. Kolattukudy), 349-418. Elsevier.
- WENDEL, T. i JÜTTNER, F. (1996) Lipxygenase mediated formation of hydrocarbons and unsaturated aldehydes in freshwater diatoms. *Phytochem.* **41**, 1445-1449.
- WETTSTEIN-KNOWLES, P. i NETTING, P.A. (1976) Alkan-1-ols and alkan-2-ols in barley epicuticular wax. *Lipids* **11**, 478-484.
- WHITE, C.M. i LEE, M.L. (1980) Identification and geochemical significance of some aromatic components of coal. *Geochim. Cosmochim. Acta* **44**, 1825-1832.
- WILKES, H., RAMRATH, A. i NEGENDANK, J.F.W. (1997) Lipid distribution in Holocene and Late Pleistocene lake sediments from Lago di Mezzano, Central Italy. A *Organic Geochemistry*. 18th International Meeting on Organic Geochemistry, Maastricht, The Netherlands, 22-26 September, 1997. Abstracts Part I, pp. 297-298. Forschungszentrum Jülich, Alemanya.

- WILLIAMS, J.A., DOLCATER, D.L., TORKELESON, B.E. i WINTERS, J.C. (1988) Anomalous concentration of specific alkylaromatic and alkylcycloparaffin components in West Texas and Michigan crude oils. *Org. Geochem.* **13**, 245-253.
- WINTERS, K., PARKER, P.L. i VAN BAALEN, C. (1969) Hydrocarbons of blue-green algae: Geochemical significance. *Science* **163**, 467-468.
- WOLFF, G.A., RUKIN, N. i MARSHALL, J.D. (1992) Geochemistry of an early diagenetic concretion from the Birchi Bed (L. Lias, W. Dorset, U.K.). *Org. Geochem.* **19**, 431-444.
- WOLFF, R.L., CHRISTIE, W.W. i COAKLEY, D. (1997) The Unusual Occurrence of 14-Methylhexadecanoic Acid in Pinaceae Seed Oils Among Plants. *Lipids* **32**, 971-973.
- WOOD, B.J.B., NICHOLS, B.W. i JAMES, A.T. (1965) The lipids and fatty acid metabolism of photosynthetic bacteria. *Biochim. Biophys. Acta* **106**, 261-273.
- WRAIGE, E.J., BELT, S.T., LEWIS, C.A., COOKE, D.A., ROBERT, J.M., MASSÉ, G. i ROWLAND, S.J. (1997) Variations in structures and distributions of C₂₅ highly branched isoprenoid (HBI) alkenes in cultures of the diatom, *Haslea ostrearia* (Simonsen). *Org. Geochem.* **27**, 497-505.
- WRAIGE, E.J., BELT, S.T., MASSÉ, G., ROBERT, J.M. i ROWLAND, S.J. (1998) Variations in distributions of C₂₅ highly branched isoprenoid (HBI) alkenes in the diatom, *Haslea ostrearia* (Simonsen): influence of salinity. *Org. Geochem.* **28**, 855-859.
- XIONG, Q.B., SHI, D.W., YAMAMOTO, H. i MIZUNO, M. (1997) Alkylamides from pericarps of *Zanthoxylum bungeanum*. *Phytochem.* **46**, 1123-1126.
- YAMAMOTO, M. i WATANABE, M. (1995) C₂₅ highly branched isoprenoid alkane and thiophenes in Neogene diatomaceous sediments, EN Japan. A *Organic Geochemistry: Developments and Applications to Energy, Climate, Environment and Human History*. 17th International Meeting on Organic Geochemistry, San Sebastián, Spain, 4-8 September, 1995. Abstracts, eds J. Grimalt i C. Dorronsoro, pp. 1039-1040. A.I.G.O.A., Donostia-San Sebastián, Espanya.
- YAMAMOTO, M., BAT-ERDENE, D., ULZIIKHISHING, P., IMAI, N. i WATANABE, Y. (1993) Paleolimnological factors controlling the distribution of organic and inorganic constituents in Lower Cretaceous Dsunbayan oil shales, eastern Mongolia. A *Organic Geochemistry. Poster Sessions from the 16th International Meeting on Organic Geochemistry*, Stavanger, Noruega, 22-24 September, 1993 (Editat per Øygard K.), pp. 407-409. Falch Hurtigtrykk, Oslo.
- YAMAMOTO, M., OGIHARA, S., YAMAMOTO, S., NARAOKA, H. i ISHIWATARI, R. (1997) Identification and occurrences of 28-norhopanoic acids in Neogene upwelling sediments. A *Organic Geochemistry*. 18th International Meeting

- on Organic Geochemistry, Maastricht, The Netherlands, 22-26 September, 1997. Abstracts Part I, pp. 471-472. Forschungszentrum Jülich, Alemanya.
- YANO, I., FURUKAWA, Y. i KUSUNOSE, M. (1971) α -oxidation of long chain fatty acids in cell free extracts of *Arthrobacter simplex*. *Biochim. Biophys. Acta* **239**, 513-516.
- YAO, M., WALKER, H.W. i LILLARD, D.A. (1970) Fatty acids from vegetative cells and spores of *Bacillus stearothermophilus*. *J. Bacteriol.* **102**, 877-878.
- YAWANARAJAH, S.R. i KRUGUE, M.A. (1994) Lacustrine shales from Stellarton Basin, Nova Scotia, Canada: organofacies variations and use of polyaromatic hydrocarbons as maturity indicators. *Org. Geochem.* **21**, 153-170.
- YON, D.A., RYBACK, G. i MAXWELL, J.R. (1982) 2,6,10-trimethyl-7-(3-methylbutyl)dodecane a novel sedimentary biological marker compound. *Tetrahedron Lett.* **23**, 2143-2146.
- YOUNGBLOOD, W.W., BLUMER, M., GUILLARD, R.L. i FIORE, F. (1971) Saturated and unsaturated hydrocarbons in marine algae. *Mar. Biol.* **8**, 190-201.
- YRUELA, I., BARBÉ, A. i GRIMALT, J.O. (1990) Determination of double bond position and geometry in linear and highly branched hydrocarbons and fatty acids from gas chromatography-mass spectrometry of epoxides and diols generated by stereospecific resin hydration. *J. Chromatogr. Science* **28**, 421-427.
- YUNKER, M.B., MACDONALD, R.W. i WHITEHOUSE, B.G. (1994) Phase association and lipid distributions in the seasonally ice-covered Arctic estuary of the Mackenzie Shelf. *Org. Geochem.* **22**, 651-699.
- YUNKER, M.B., MACDONALD, R.W., VELTKAMP, D.J. i CRETNEY, W.J. (1995) Terrestrial and marine biomarkers in a seasonally ice-covered Arctic estuary-integration of multivariate and biomarker approaches. *Mar. Chem.* **49**, 1-49.
- ZANDER, J.M., CASPI, E., PANDEY, G.N. i MITRA, C.R. (1969) The presence of tetrahymanol in *Oleandra wallichii*. *Phytochem.* **8**, 2265-2267.
- ZEGOUAGH, Y., DERENNE, S., LARGEAU, C. i SALIOT, A. (1995) Analysis of different acid fractions in surface sediments from Lena River (Siberia) and adjacent areas in the Laptev Sea. I. Analysis of the carboxylic acids released via sequential treatments. A *Organic Geochemistry: Developments and Applications to Energy, Climate, Environment and Human History*. 17th International Meeting on Organic Geochemistry, San Sebastián, Spain, 4-8 September, 1995. Abstracts, eds J. Grimalt i C. Dorronsoro, pp. 988-990. A.I.G.O.A., Donostia-San Sebastián, Espanya.
- ZEGOUAGH, Y., DERENNE, S., LARGEAU, C. i SALIOT, A. (1996) Organic matter sources and early diagenetic alterations in Arctic surface sediments (Lena River Delta and Laptev Sea, Eastern Siberia). I. Analysis of the carboxylic acids released via

- sequential treatments. *Org. Geochem.* **24**, 841-857.
- ZENG, Y.B., WARD, D.M., BRASSELL, S.C. i EGLINTON, G. (1992a) Biogeochemistry of hot spring environments 3. Apolar and polar lipids in the biologically active layer of a cyanobacterial mat. *Chem. Geol.* **95**, 347-360.
- ZENG, Y.B., WARD, D.M., BRASSELL, S.C. i EGLINTON, G. (1992b) Biogeochemistry of hot spring environments 2. Lipid compositions of Yellowstone (Wyoming, USA) cyanobacterial and *Chloroflexus* mats. *Chem. Geol.* **95**, 327-345.
- ZHANG, J., FU, J., SHENG, G., LIU, D. i CHEN, J. (1995) Identification of source rocks in the Tarin Basin, Northwest China. A *Organic Geochemistry: Developments and Applications to Energy, Climate, Environment and Human History*. 17th International Meeting on Organic Geochemistry, San Sebastián, Spain, 4-8 September, 1995. Abstracts, eds J. Grimalt i C. Dorronsoro, pp. 164-165. A.I.G.O.A., Donostia-San Sebastián, Espanya.
- ZIMMERLE, W. (1995) Sedimentology of rocks important to hydrocarbon exploration. *A Petroleum Sedimentology*. Kluwer Academic Publishers, pp. 108-127. Stuttgart, Alemanya.
- ZUNDEL, M. i ROHMER, M. (1985a) Prokaryotic triterpenoids. 1. 3 β -Methylhopanoids from *Acetobacter* species and *Methylococcus capsulatus*. *Eur. J. Biochem.* **150**, 23-27.
- ZUNDEL, M. i ROHMER, M. (1985b) Prokaryotic triterpenoids. 3. The biosynthesis of 2 β -methylhopanoids and 3 β -methylhopanoids of *Methylobacterium organophilum* and *Acetobacter pasteurianus* ssp. *pasteurianus*. *Eur. J. Biochem.* **150**, 35-39.
- ZUMBERGE, J.E. (1984) Source rocks of the Luna formation (Upper Cretaceous) in the middle Magdalena Valley, Colombia. A "Petroleum Geochemistry and Source Rocks Potential of Carbonates Rocks". *A.A.P.G. Stud. Geol.* **18**, 127-134.
- ZYGADLO, J.A., PIGNATA, M.L., GONZÁLEZ, C.M. i LEVIN, A. (1993) Alkanes in lichens. *Phytochem.* **32**, 1453-1456.