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PROFESSIONAL EXPERIENCE

CALIFORNIA INSTITUTE OF TECHNOLOGY, PASADENA, CA
Allen V.C. Davis and Lenabelle Davis Leadership Chair, CEMI — 2020-present

CALIFORNIA INSTITUTE OF TECHNOLOGY, PASADENA, CA — 2016-present
James Irvine Professor of Environmental Science and Geobiology

CALIFORNIA INSTITUTE OF TECHNOLOGY, PASADENA, CA — 2010-present
Professor of Geobiology, Division of Geological and Planetary Sciences

CALIFORNIA INSTITUTE OF TECHNOLOGY, PASADENA, CA — 2010
Associate Professor of Geobiology, Division of Geological and Planetary Sciences

CALIFORNIA INSTITUTE OF TECHNOLOGY, PASADENA, CA — 2004-2010
Assistant Professor of Geobiology, Division of Geological and Planetary Sciences

MONTEREY BAY AQUARIUM RESEARCH INSTITUTE, MOSS LANDING, CA — 2008-present
Adjunct Scientist

MBL MICROBIAL DIVERSITY COURSE, WOODS HOLE, MA — 2009
Faculty in residence

EDUCATION and TRAINING

Postdoctoral: NASA AMES RESEARCH CENTER — 2002-2004
National Research Council Associate
Advisor Dr. David DesMarais

Graduate: UNIVERSITY OF CALIFORNIA, SANTA BARBARA — 1996-2001
Ph.D. Ecology, Evolution, and Marine Biology
Thesis advisor: Dr. Edward F. DeLong

Undergraduate: UNIVERSITY OF CALIFORNIA, SANTA BARBARA — 1990-1994
Bachelor's Aquatic Biology

Other training: MONTEREY BAY AQUARIUM RESEARCH INSTITUTE — 1998-2001
Graduate Research Assistant

SFSU TIBURON CENTER FOR ENVIRONMENTAL STUDIES — 1994-1995
Research Technician

HONORS & REGOGNITION

Fellow American Geophysical Union (AGU)	2021
Fellow American Academy of Arts and Sciences (AAAS)	2020
Director Caltech Center for Environmental Microbial Interactions (CEMI)	2020
CIFAR Fellow	2019
U Bremen Excellence Chair	2019
NOMIS Distinguished Scientist	2018
Cozzarelli Prize – PNAS, Applied Biological, Agricultural, and Environmental Sciences	2017
MacArthur Fellow	2016
Fellow American Academy of Microbiology	2015
Fred Shair Diversity Award (Caltech Center for Diversity)	2014
Investigator Gordon and Betty Moore foundation Marine Microbiology Initiative	2013
Young investigator award: International Society of Microbial Ecology (ISME)	2012
Presidential Early Career Award in Science and Engineering (PECASE)	2011
GAST Lectureship, European Association of Geochemistry	2011
DOE Early Career Research Award	2010
Gordon and Betty Moore Foundation Young Investigator	2005
National Research Council Fellow, NASA Ames Research Center	2001

(d) Representative Synergistic Activities

- Co-organizer 4th International Workshop on Microbial life under extreme energy limitation (Denmark, Sept 2022)
- Member President's Diversity Council (2016-2022) and GPS Diversity Equity and Inclusion committee (2019-present)
- Chair elect: microbial C1 metabolism Gordon Research conference (July 2018)
- Invited lecturer and faculty in Residence, MBL Microbial Diversity Course (2008-2012 and 2014- 2017)
- Director Caltech's Kerckhoff Marine Laboratory (2017-present)
- Co-Director Agouron and Simons Foundation International Geobiology summer course (2017-2022)
- Journal Editor for *Environmental Microbiology* (2012-2016)

Graduate Advisors and Postdoctoral Sponsors

Edward DeLong (UCSB & MBARI, current U. of Hawaii) and David DesMarais (NASA Ames Research Center)

Ph.D. Graduate Student Supervision

Current: J. Bosche (MARUM, U. Bremen), J. Mullahoo (Environmental Science and Engineering), R. Wipfler (Geobiology), S. Parra (Geobiology), Y. Guo (Environmental Science and Engineering); A. Narayanan (Biology), S. Lim (Geobiology)

Co-advise: A. Johnson (Biological Engineering); C. Rusley (Geobiology), S. Silverman (Geobiology), D. Osario (Geobiology)

Previous: C. Sanders (co-advise Planetary Science/Geobiology, 2022), G. Chadwick, (2020, Geobiology), K. Metcalfe (2020, Geobiology), S. Mullin (2020, Geobiology), S. Esswein (2020, Biology Md/PhD), H. Yu (2017, Environmental Science and Engineering, postdoc Caltech), P. Magyar (2017, geochemistry postdoc Switzerland), E. Trembath-Reichert (2016, Geobiology, postdoc WHOI, assist. professor ASU in 2019), D. Case (2016, Geochemistry), J. Marlow (2015, Geobiology, Harvard postdoc, Assist. Professor Boston Univ.), A. Green-Saxena (2013, Biology), A. Dekas (2013, Geobiology, Assist. Professor Stanford), B. Harrison (2012, Geochemistry), C. Gammon (2008, Geobiology Masters), K. Turk (2005, Geobiology Masters)

Postdoctoral Scholar Supervision

Current: Francisco Martinez (2022-present); Dan Utter (2021-present); Magdelena Mayr (2021-present); Rodney Tollerson (2021-present); Kriti Sharma (2020-present); Alon Philosof (2018-present); Yamini Jangir (2018-present); Antoine Crème (co-advised 2017-present), Ranjani Murali (2017-present).

Previous: Yanzhe Zhu (2021-2023); Rafa Laso-Perez (2020-2021); Fabai Wu (2017-2021, assist. Professor Zhejiang University), Daan Speth (2016-2021, Sr. researcher U. Vienna); Haley Sapers (2016-2020, Univ. York), K. Dawson (2012-2017, assist. Professor Rutgers), A. Pasulka (2013-2017 assist. Professor Cal Poly SLO), C. Skennerton (2014-2017, industry); R. Hatzenpichler (2011-2016, Assoc. Professor Montana State University), S. McGlynn (2011-2014, professor, ELSI, Tokyo Tech), E. Wilbanks (2014-2016 assist. Professor UCSB), S. Scheller (2013-2016, assist. Professor University Helsinki), D. Smith (2013-2016, postdoc Wash U), J. Steele (microbiologist, Southern California Coastal Water Research Project), J. Glass (assoc professor Georgia Tech), D. Fike (professor Washington University), J. Bailey (assoc. professor University of Minnesota), R. Poretsky (assoc. professor University of Illinois at Chicago), O. Mason (assoc. professor, Florida state), A. Pernthaler (Group Leader Hemholtz center, Leipzig), H. Zhang (Research assistant professor, Virginia Tech).

REFEREED PUBLICATIONS (orcid.org/0000-0002-5374-6178)

2023

1) Utter, D.R. and **Orphan, V.J**., 2023. Gifts hidden in shadowy genome islands. Cell, 186(1), pp.5-7.

2) Laso-Pérez, R., Wu, F., Crémière, A., Speth, D.R., Magyar, J.S., Zhao, K., Krupovic, M. and **Orphan, V.J**., 2023. Evolutionary diversification of methanotrophic ANME-1 archaea and their expansive virome. Nature Microbiology, pp.1-15.

3) Murali, R., Yu, H., Speth, D., Wu, F., Metcalfe, K.S., Cremiere, A., Laso-Perez, R., Malmstrom, R., Goudeau, D., Woyke, T. and Hatzenpichler, R…., **Orphan, VJ**. 2022. Physiological adaptation of sulfate reducing bacteria in syntrophic partnership with anaerobic methanotrophic archaea. bioRxiv, pp.2022-11. (in review Plos Bio)

2022

4) Wegener, G., Laso-Pérez, R., **Orphan, V.J**. and Boetius, A., 2022. Anaerobic degradation of alkanes by marine archaea. Annual Review of Microbiology, 76, pp.553-577.

5) Wu, F, D. Speth, A. Philosof, A. Cremiere, A. Narayanan, R. Barco, S. Connon, J. Amend, I. Antoshechkin, **V.J. Orphan**. (2022) Unique mobile elements and scalable gene flow at the prokaryote-eukaryote boundary revealed by circularized Asgard archaea genomes. Nature Microbiology. Jan. p1-13.

6) Lingappa, U.F., Stein, N.T., Metcalfe, K.S., Present, T.M., **Orphan, V.J**., Grotzinger, J.P., Knoll, A.H., Trower, E.J., Gomes, M.L. and Fischer, W.W., 2022. Early impacts of climate change on a coastal marine microbial mat ecosystem. Science Advances, 8(21), p.eabm7826.

7) Schwartzman, J.A., Ebrahimi, A., Chadwick, G., Sato, Y., Roller, B.R., **Orphan, V.J.** and Cordero, O.X., 2022. Bacterial growth in multicellular aggregates leads to the emergence of complex life cycles. Current Biology, 32(14), pp.3059-3069.

8) Yu, H., Speth, D.R., Connon, S.A., Goudeau, D., Malmstrom, R.R., Woyke, T. and **Orphan, V.J.,** 2022. Community structure and microbial associations in sediment-free methanotrophic enrichment cultures from a marine methane seep. Applied and Environmental Microbiology, 88(11), pp.e02109-21.

9) Heryakusuma, C., Susanti, D., Yu, H., Li, Z., Purwantini, E., Hettich, R.L., **Orphan, V.J.** and Mukhopadhyay, B., 2022. A reduced F420-dependent nitrite reductase in an anaerobic methanotrophic archaeon. Journal of Bacteriology, 204(7), pp.e00078-22.

10) McGlynn, S.E., Perkins, G., Sim, M.S., Mackey, M., Deerinck, T.J., Thor, A., Phan, S., Ballard, D., Ellisman, M.H. and **Orphan, V.J.,** 2022. A Cristae-Like Microcompartment in Desulfobacterota. Mbio, 13(6), pp.e01613-22.

11) Himmler, T., Crémière, A., Birgel, D., Wirth, R., **Orphan, V.J.,** Kirsimäe, K., Knies, J., Peckmann, J. and Lepland, A., 2022. Putative fossils of chemotrophic microbes preserved in seep carbonates from Vestnesa Ridge, off northwest Svalbard, Norway. Geology, 50(2), pp.169-173.

12) Speth, D.R., Yu, F.B., Connon, S.A., Lim, S., Magyar, J.S., Peña-Salinas, M.E., Quake, S.R. and **Orphan, V.J.,** 2022. Microbial communities of Auka hydrothermal sediments shed light on vent biogeography and the evolutionary history of thermophily. The ISME Journal, pp.1-15.

13) Chadwick, G. L., Skennerton, C. T., Laso-Pérez, R., Leu, A. O., Speth, D. R., Yu, H., ... & **Orphan, V. J**. (2022). Comparative genomics reveals electron transfer and syntrophic mechanisms differentiating methanotrophic and methanogenic archaea. PLoS biology, 20(1), e3001508.

14) Aronson, H.S., Monteverde, D.R., Barnes, B.D., Johnson, B.R., Zawaski, M.J., Speth, D.R., Wang, X.T., Wu, F., Webb, S.M., Trower, E.J. and Magyar, J.S….**Orphan, V** 2022. Sulfur cycling at natural hydrocarbon and sulfur seeps in Santa Paula Creek, CA. Geobiology, 20(5), pp.707-725.

2021

15) Marlow, J et al. (2021) Carbonate-hosted microbial communities are prolific and pervasive methane oxidizers at geologically diverse marine methane seep sites. PNAS. 10.1073/pnas.2006857118

16) Yu, H. A. Leu; G. Tyson **V.J Orphan** et al. (2021) Sulfate stimulates but is not respired by diverse anaerobic methanotrophic archaea. ISME Journal DOI: 10.1038/s41396-021-01047-0

17) Lloyd et al. (2021) Methoxyl stable isotopic constraints on the origins and limits of coal-bed methane. Science

18) Ashford. O et al (2021) A chemosynthetic ecotone—“chemotone”—in the sediments surrounding deep-sea methane seeps. Limno. Oceano. DOI: 10.1002/lno.11713

19) Sim, M.S., Skennerton, C.T. and **Orphan, V.J.,** 2021. Physiological, genomic, and sulfur isotopic characterization of methanol metabolism by *Desulfovibrio carbinolicus*. PloS one, 16(1), p.e0245069.

20) He, X, G. Chadwick, C. Kempes, **V. Orphan**, C. Miele (2021) Controls on interspecies electron transport and size limitation of anaerobically methane oxidizing microbial consortia. mBIO. DOI: 10.1128/mBio.03620-20

21) Philips, A, et al. (2021) Microbial succession and dynamics in meromictic Mono Lake, California. Geobiology. doi:10.1111/gbi.12437

22) He, X, G. Chadwick, F.Jimenez, **V. Orphan**, C. Miele (2021) Spatially Resolved Electron Transport through Anode-Respiring Geobacter sulfurreducens Biofilms: Controls and Constraints. ChemElectroChem. DOI: 10.1002/celc.202100111R1

2020

23) Metcalfe, K.S., Murali, R.S., Mullin, S.W., Connon, S.A. and **Orphan, V.J.,** (2020) Experimentally-validated correlation analysis reveals new anaerobic methane oxidation partnerships with consortium-level heterogeneity in diazotrophy. The ISME Journal 1-20.

24) Fincker, M., Huber, J.A., **Orphan, V.J.,** Rappé, M.S., Teske, A. and Spormann, A.M., 2020. Metabolic strategies of marine subseafloor Chloroflexi inferred from genome reconstructions. Environmental Microbiology. 8:3188-3204

25) Goffredi, S.K., Tilic, E., Mullin, S.W., Dawson, K.S., Keller, A., Lee, R.W., Wu, F., Levin, L.A., Rouse, G.W., Cordes, E.E. and **Orphan, V.J**., 2020. Methanotrophic bacterial symbionts fuel dense populations of deep-sea feather duster worms (Sabellida, Annelida) and extend the spatial influence of methane seepage. Science Advances, 6(14), p.eaay8562.

26) Mullin, S.W., Wanger, G., Kruger, B.R., Sackett, J.D., Hamilton-Brehm, S.D., Bhartia, R., Amend, J.P., Moser, D.P. and **Orphan, V.J**., 2020. Patterns of in situ Mineral Colonization by Microorganisms in a~ 60° C Deep Continental Subsurface Aquifer. Frontiers in microbiology, 11, p.2573.

27) Leu, A.O., McIlroy, S.J., Ye, J., Parks, D.H., **Orphan, V.J**. and Tyson, G.W., 2020. Lateral gene transfer drives metabolic flexibility in the anaerobic methane-oxidizing archaeal family Methanoperedenaceae. MBio, 11(3).

28) Houghton, J.L., Jones, C., Dawson, K.S., **Orphan, V.,** Gomes, M.L. and Fike, D.A., 2020. Resolving micron-scale heterogeneity in porewater $\delta^{34}S(H_2S)$ by combining films for in-situ sulfide capture and secondary ion mass spectrometry. Marine Chemistry. in press.

29) Leu, A.O., Cai, C., McIlroy, S.J., Southam, G., **Orphan, V.J.,** Yuan, Z., Hu, S. and Tyson, G.W., 2020. Anaerobic methane oxidation coupled to manganese reduction by members of the Methanoperedenaceae. The ISME journal, 14(4), pp.1030-1041.

2019

30) Chadwick, G. L., Jiménez-Otero, F., Gralnick, J. A., Bond, D. R., **Orphan, V. J.** (2019). NanoSIMS imaging reveals metabolic stratification within current-producing biofilms. PNAS 116(41), pp.20716-20724.

31) e Drigo, R.A., Lev-Ram, V., Tyagi, S., Ramachandra, R., Deerinck, T., Bushong, E., Phan, S., **Orphan, V**., Lechene, C., Ellisman, M.H. and Hetzer, M.W., 2019. Age Mosaicism across Multiple Scales in Adult Tissues. Cell Metabolism 30:343-351e3.

32) Bublitz, D.C., Chadwick, G.L., Magyar, J.S., Sandoz, K.M., Brooks, D.M., Mesnage, S., Ladinsky, M.S., Garber, A.I., Bjorkman, P.J., **Orphan, V.J.** and McCutcheon, J.P., 2019. Peptidoglycan production by an insect-bacterial mosaic. Cell, 179(3), pp.703-712.

33) Cavicchioli, R., Ripple, W. J., Timmis, K. N., Azam, F., Bakken, L. R., Baylis, M., ... **V. Orphan**… & Crowther, T. W. (2019). Scientists' warning to humanity: microorganisms and climate change. Nature Reviews Microbiology, 17: 569-586.

34) Bird, L.R., Dawson, K.S., Chadwick, G.L., Fulton, J.M., **Orphan, V.J.** and Freeman, K.H., 2019. Carbon isotopic heterogeneity of coenzyme F430 and membrane lipids in methane-oxidizing archaea. Geobiology, 17(6), pp.611-627.

35) Sim, M.S., Ogata, H., Lubitz, W., Adkins, J.F., Sessions, A.L., **Orphan, V.J.** and McGlynn, S.E., 2019. Role of APS reductase in biogeochemical sulfur isotope fractionation. Nature communications, 10(1), p.44.

36) Stamenković, V., L. W. Beegle, K. Zacny, D. D. Arumugam, P. Baglioni, N. Barba, J. Baross,… **V. Orphan**, &…. (2019) The next frontier for planetary and human exploration. Nature Astronomy. 3, no. 2: 116.

37) Sapers, H.M., Razzell Hollis, J., Bhartia, R., Beegle, L.W., **Orphan, V.J.** and Amend, J.P., 2019. The cell and the sum of its parts: patterns of complexity in biosignatures as revealed by deep UV Raman spectroscopy. Frontiers in microbiology, 10, p.679.

38) Boyd, J.A., Jungbluth, S.P., Leu, A.O., Evans, P.N., Woodcroft, B.J., Chadwick, G.L., **Orphan, V.J**., Amend, J.P., Rappé, M.S. and Tyson, G.W., 2019. Divergent methyl-coenzyme M reductase genes in a deep-subseafloor Archaeoglobi. The ISME journal, 13(5), p.1269.

2018

39) Chadwick, G, J. Hemp, W. Fischer, **V. J. Orphan** (2018) Convergent evolution of unusual complex I homologs with increased proton pumping capacity: energetic and ecological implications. ISMEJ. 12:2668.

40) Yu, H., Susanti, D., McGlynn, S.E., Skennerton, C.T., Chourey, K., Iyer, R., Scheller, S., Tavormina, P.L., Hettich, R.L., Mukhopadhyay, B. and **Orphan, V.J**., 2018. Comparative Genomics and Proteomic Analysis of Assimilatory Sulfate Reduction Pathways in Anaerobic Methanotrophic Archaea. Frontiers in microbiology, 9.

41) Yung, Y. L., P. Chen, K. Nealson, S. Atreya, P. Beckett, J. G. Blank, B. Ehlmann…**V. Orphan**… et al. "Methane on Mars and Habitability: Challenges and Responses." (2018): 1221-1242.

42) Speth, D and **V.J. Orphan** (2018) Metabolic marker gene mining provides insight in global mcrA diversity and, coupled with targeted genome reconstruction, sheds further light on metabolic versatility potential of the Methanomassiliicoccales. PeerJ

43) Ijiri, A et al., (2018) Deep-biosphere methane production stimulated by geofluids in the Nankai accretionary complex. Science Advances. 4(6) eaao4631

44) McGlynn, S.E., Chadwick, G.L., O'Neill, A., Mackey, M., Thor, A., Deerinck, T.J., Ellisman, M.H. and **V.J. Orphan**. 2018. Subgroup characteristics of marine methane-oxidizing ANME-2 archaea and their syntrophic partners revealed by integrated multimodal analytical microscopy. Applied and Environmental Microbiology, pp.AEM-00399.

45) Dekas, A.E., Fike, D.A., Chadwick, G.L., Green-Saxena, A., Fortney, J., Connon, S.A., Dawson, K.S. and **Orphan, V.J.,** 2018. Widespread nitrogen fixation in sediments from diverse deep-sea sites of elevated carbon loading. Environmental microbiology, 20(12), pp.4281-4296.

46) Michel, A.J., Ward, L.M., Goffredi, S.K., Dawson, K.S., Baldassarre, D.T., Brenner, A., Gotanda, K.M., McCormack, J.E., Mullin, S.W., O'Neill, A. and Tender, G.S., J. A. Uy, K. Yu, **V.J. Orphan** and J. Chavez. 2018. The gut of the finch: uniqueness of the gut microbiome of the Galápagos vampire finch. Microbiome, 6(1), p.167.

2017

47) Case, D, A Ijiri, Y Morono, P Tavormina, **V Orphan**, F Inagaki (2017) Aerobic and anaerobic methanotrophic communities associated with methane hydrates exposed on the seafloor: A high-pressure sampling and stable isotope-incubation experiment. Frontiers in Microbiology. 8: 2569

48) Pasulka, A.L., Thamatrakoln, K., Kopf, S.H., Guan, Y., Poulos, B., Moradian, A., Sweredoski, M.J., Hess, S., Sullivan, M.B., Bidle, K.D. and **Orphan, V.J**., 2017. Interrogating marine virus-host interactions and elemental transfer with BONCAT and nanoSIMS-based methods. Environmental microbiology. 20(2), pp.671-692.

49) Fike, D.A., J.L. Houghton, S.E. Moore, W.P. Gilhooly III, K.S. Dawson, G.K. Dreshel, J.P. Amend, and **V. J. Orphan** (2017) Spatially resolved capture of hydrogen sulfide from the water column and sedimentary pore waters for abundance and stable isotopic analysis. Marine Chemistry. 197: 26-37

50) Trembath-Reichert, E., Y. Morono, A. Ijiri, T. Hoshino, K.S Dawson, F. Inagaki and **V. J. Orphan** (2017). Methyl compound use and slow growth characterize life in 2-km-deep subseafloor coal beds. Proceedings of the National Academy of Sciences. 114:e9206-9215

51) Marlow, J.J., Steele, J.A., Ziebis, W., Scheller, S., Case, D., Reynard, L.M. and **Orphan, V.J**., 2017. Monodeuterated Methane, an Isotopic Tool To Assess Biological Methane Metabolism Rates. mSphere, 2(4), pp.e00309-17.

52) Zhu, Y., Zhao, R., Piehowski, P.D., Moore, R.J., Lim, S., **Orphan, V.J**., Paša-Tolić, L., Qian, W.J., Smith, R.D. and Kelly, R.T. (2017). Subnanogram proteomics: impact of LC column selection, MS instrumentation and data analysis strategy on proteome coverage for trace samples. International Journal of Mass Spectrometry.

53) Sim, M-S, G. Paris, J.F. Adkins, **V.J. Orphan**, and A.L Sessions (2017). Quantification and isotopic analysis of intracellular sulfur metabolites in the dissimilatory sulfate reduction pathway. Geochimica et Cosmochimica Acta. 106:57-72.

54) Skennerton, C.T., Chourey, K., Iyer, R., Hettich, R.L., Tyson, G.W. and **Orphan, V.J.,** 2017. Methane-Fueled Syntrophy through Extracellular Electron Transfer: Uncovering the Genomic Traits Conserved within Diverse Bacterial Partners of Anaerobic Methanotrophic Archaea. mBio, 8(4), pp.e00530-17.

55) Smith, D, A. Sessions, N. Dalleska, and **V.J. Orphan** (2017). Rapid Quantification and Isotopic Analysis of Dissolved Sulfur Species. Rapid Communications in Mass Spectrometry. 31:791-803

56) Pasulka, A.L., Goffredi, S.K., Tavormina, P.L., Dawson, K.S., Levin, L.A., Rouse, G.W. and **Orphan, V.J.,** 2017. Colonial tube-dwelling ciliates influence methane cycling and microbial diversity within methane seep ecosystems. Frontiers in Marine Science, 3, p.276.

57) Terrado, R, Pasulka, A.L., Lie, A.A.Y., **Orphan, V.J**., Heidelberg, K.B. and Caron, D.A. 2017. Autotrophic and heterotrophic acquisition of carbon and nitrogen by a mixotrophic chrysophyte established through stable isotope analysis. ISMEJ. 11:2022.

58) Glass, J.B., Chen, S., Dawson, K.S., Horton, D.R., Vogt, S., Ingall, E.D., Twining, B.S. and **Orphan, V.J**., 2017. Trace metal imaging of sulfate-reducing bacteria and methanogenic archaea at single-cell resolution by synchrotron X-ray fluorescence imaging Geomicrobiology Journal, pp.1-9.

59) Tavormina, P. L. and Kellermann, M. Y. and Antony, C P., Dublier, N., and **Orphan, VJ**. (2017) Starvation and recovery in the deep-sea methanotroph *Methyloprofundus sedimenti.* Molecular Microbiology. 103:242-252.

2016

60) Hatzenpichler, R., Connon, S.A., Goudeau, D., Malmstrom, R.R., Woyke, T. and **Orphan, V.J**., 2016. Visualizing in situ translational activity for identifying and sorting slow-growing archaeal− bacterial consortia. Proceedings of the National Academy of Sciences, 30(17), 1923-1940.

61) Magyar, P., **Orphan**, **V**. and Eiler, J., 2016. Measurement of rare isotopologues of nitrous oxide by high-resolution multi-collector mass spectrometry. Rapid Communications in Mass Spectrometry, 76(6): 2054-2054

62) Dawson, K. S., Scheller, S., Dillon, J. G., and **Orphan, V. J.** (2016). Stable isotope phenotyping via cluster analysis of NanoSIMS data as a method for characterizing distinct microbial ecophysiologies and sulfur-cycling in the environment. Frontiers in Microbiology, 7, 774

63) Miranda, P. J. and McLain, N. K. and Hatzenpichler, R., **V.J. Orphan** and J. Dillon (2016) Characterization of Chemosynthetic Microbial Mats Associated with Intertidal Hydrothermal Sulfur Vents in White Point, San Pedro, CA, USA. Frontiers in Microbiology, 7,1163

64) Trembath-Reichert, E., Case, D. H., and **Orphan, V. J**. (2016). Characterization of microbial associations with methanotrophic archaea and sulfate-reducing bacteria through statistical comparison of nested Magneto-FISH enrichments. PeerJ, 4, e1913.

65) Fradet, D. , P. Tavormina and **V. J. Orphan** (2016) Members of the methanotrophic genus Methylomarinum inhabit inland mud pots. PeerJ. 4 p.e2116

66) Scheller, S H. Yu, G. Chadwick, S. McGlynn, and **V.J. Orphan** (2016) Artificial electron acceptors decouple archaeal methane oxidation from sulfate reduction. Science. 351(6274), pp.703-707.

67) Kopf, S., A. L. Sessions, E. Cowley, C. Reyes, L. VanSambeek, Y. Hu, **V. J. Orphan**, R. Kato, & D. Newman (2016) Trace incorporation of heavy water reveals slow and heterogeneous pathogen growth rates in cystic fibrosis sputum. Proc. Natl. Acad. Sci. USA. 113:110-116.

68) Skennerton,C., M. Haroon, A. Briegel, J. Shi, G.Jensen, G. Tyson, and **V. J. Orphan** (2016). Phylogenomic Analysis of Candidatus 'Izimaplasma' species: Free-living representatives from a Tenericutes Clade found in Methane Seeps. ISMEJ

69) Marlow, J, C. Skennerton, Z. Li, K. Chourey, R. Hettich, C. Pan, **V. J. Orphan** (2016) Proteomic Stable Isotope Probing Reveals Biosynthesis Dynamics of Slow Growing Methane Based Microbial Communities. Frontiers in Microbiology.7.

2015

70) McGlynn, S, G. Chadwick, C. Kempes, & **V.J. Orphan** (2015) Single cell activity reveals direct electron transfer in methanotrophic consortia. Nature. 526:531-535.

71) Evans, P. N., Parks, D. H., Chadwick, G. L., Robbins, S. J., **Orphan, V. J.,** Golding, S. D., & Tyson, G. W. (2015). Methane metabolism in the archaeal phylum Bathyarchaeota revealed by genome-centric metagenomics. Science,350(6259), 434-438.

72) Dekas, A.E., Connon, S.A., Chadwick, G.L., Trembath-Reichert, E. and **Orphan, V.J.,** 2015. Activity and interactions of methane seep microorganisms assessed by parallel transcription and FISH-NanoSIMS analyses. The ISME journal. 10:678-692.

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