

Curriculum Vitae

Michael Donald Tryon

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Education

Post-graduate: Scripps Institution of Oceanography, UCSD, La Jolla, CA. 3/2002-1/2005.

Graduate: Ph.D., Earth Science, 2002, Scripps Inst. of Oceanography, UCSD, La Jolla CA;

Dissertation: The development and application of a new benthic aqueous flux meter for very low to moderate discharge rates

Undergraduate: B.S. Earth Science, 1995, University of California, San Diego, La Jolla, CA.

Employment

Project Scientist, Scripps Inst. of Oceanography, La Jolla, CA, 1/2005-present.

Post-Doctoral Researcher, Scripps Inst. of Oceanography, La Jolla, CA, 3/2002-1/2005.

Graduate Teaching Assistant, Field Geology, Optical Mineralogy; 1996-2001.

Graduate Research Assistant, Scripps Inst. of Oceanography, La Jolla, CA; 1995-2002.

Research Assistant, Scripps Inst. of Oceanography, La Jolla, CA; 1992 to 1995.

Research Interests

Physical, hydrologic, and chemical processes associated with active submarine fault zones

Physical, hydrologic, and chemical processes associated with cold seeps and mud volcanoes

Physical, hydrologic, and geochemical consequences of gas hydrate formation and destruction

Physical processes associated with the structural evolution of convergent margins

Seafloor instrument development

Current Projects

PI on NSF/IODP grant 1/10-12/11: "Muddy Waters: Deep-seated fluid flow processes, seismic faulting and mud volcanism in a mature collision zone"

PI on NSF grant 3/07-2/10: "Hydrologic and Geochemical Measurements During the Marnaut Project, Marmara Sea, Turkey"

PI on NSF grant 1/08-12/09: "Development Of A Next Generation Subseabed Pore Pressure Instrument For Marine Hydrogeology: The PUPPI-II"

PI on research contract with IFM-GEOMAR 8/07-7/10: "The West Nile Delta Project"

PI on research contract with ESONET 5/08-4/11: "Multidisciplinary Seafloor Observatories of Seismogenic Hazards Monitoring in the Marmara Sea" an ESONET Demonstration Mission (MarmaraDM)

coPI on NSF grant 1/07-12/09: "A Moored Geodetic Seafloor Monitoring System (GEOCE)"

coPI on NSF grant 4/07-3/09: "Hydrologic Monitoring at the Nantroseize OOST Zone: A Pilot Study"

Service/Outreach/Mentoring

UNOLS Deep Submergence Science Committee (DESSC) member (appointment 2006-2012)

Reviewer for numerous publications and NSF and IODP proposals

Judge for the Southern California Marine Advanced Technology Education Center ROV Competition for Middle and High School students

Mentor/advisor for Ph.D. student Alison LaBonte (2002-2007)

Mentor/advisor for STAR program student Dawn James (2003)

Ph.D. committee member / advisor for Jared Kluesner (current)

Ph.D. committee member / advisor for Peter Barry (current)

Seagoing experience

5-10 weeks per year at sea (1995-2008)

Chief Scientist – R/V Atlantis AT15-5; June 2006

Chief Scientist – R/V Ewing EW 0212; December 2003

Experience using a variety of deep submergence vehicles including Alvin, Nautila, Johnson Sea Link, Delta, Oceanic Explorer, Jason (I&II), Hyper Dolphin, Scorpio, Ventana, and ROPOS – 90 hours manned submersible and >1000 hours ROV time

Honors

Regents' Fellowship, Scripps Institution of Oceanography; 1995-1996.

Dean's list, University of California, San Diego; 1991-1995.

Memberships

American Geophysical Union

Marine Technology Society

Recent and current collaborators

Achim Kopf – U. Bremen

Lisa Levin – SIO

Pierre Henry – College de France

David Chadwell – SIO

Warner Brückmann – GEOMAR

Marta Torres – Oregon State

Anthony Rathburn – Indiana State

Uwe Send – SIO

Gerard Fryer – U. Hawaii

Kevin Brown – SIO

David Hilton – SIO

Louis Géli - IFREMER

Publications

Published or recently submitted manuscripts

Tryon, M.D., K.M. Brown, M.E. Torres, A.M. Trehu, J. McManus, and R.W. Collier, Measurements of transience and downward fluid flow near episodic methane gas vents, Hydrate Ridge, Cascadia, *Geology*, 27 (12), 1075-1078, 1999.

Tryon, M.D., K.M. Brown, L. Dorman, and A. Sauter, A new benthic aqueous flux meter for very low to moderate discharge rates, *Deep-Sea Research, Part I*, 48 (9), 2121-2146, 2001.

Tryon, M.D., and K.M. Brown, Complex flow patterns through forearc gas hydrates and their impact on seep biota, *Geophysical Research Letters*, 28 (14), 2863-2866, 2001.

Tryon, M.D., K.M. Brown, M.E. Torres, Fluid and chemical fluxes in and out of sediments hosting hydrate deposits on Hydrate Ridge, OR, II: Hydrological processes, *Earth and Planetary Science Letters*, 201 (3-4), 541-557, 2002.

Torres, M.E., J. McManus, D. Hammond, M.A de Angelis, K. Heeschen, S.L. Colbert, M.D. **Tryon**, K.M. Brown, and E. Suess, Fluid and chemical fluxes in and out of sediments hosting hydrate deposits on Hydrate Ridge, OR, I: Hydrological provinces, *Earth and Planetary Science Letters*, 201 (3-4), 525-540, 2002.

Tryon, M.D., *The Development and Application of a New Benthic Aqueous Flux Meter for Very Low to Moderate Discharge Rates*, Doctoral Dissertation, University of California, San Diego, 2002.

Spinelli, G.A., A.T. Fisher, C.G. Wheat, M.D. **Tryon**, K.M. Brown, and A.R. Flegal, Groundwater seepage into San Francisco Bay estimated from seepage meters and porewater geochemistry: Implications for dissolved metals budgets, *Water Resources Research*, 38 (7), 19 pp., 2002.

Levin, L.A., W. Ziebis, G.F. Mendoza, V.A. Growney, M.D. **Tryon**, K.M. Brown, C. Mahn, J.M. Gieskes, and A.E. Rathburn, Spatial heterogeneity of macrofauna at northern California methane seeps: influence of sulfide concentration and fluid flow, *Marine Ecology Progress Series*, 265, 123-139, 2003.

- Tryon**, M.D. and K.M. Brown, Fluid and chemical cycling at Bush Hill: Implications for gas- and hydrate-rich environments, *Geology, Geophysics, and Geosystems (G-Cubed)*, 5 (12), 1-7, 2004.
- Brown, K.M., M.D. **Tryon**, H.R. DeShon, L.M. Dorman, and S. Schwartz, Correlated Transient Fluid Pulsing and Seismic Tremor in the Costa Rica Subduction Zone, *Earth and Planetary Science Letters*, 238, 189-203, 2005.
- LaBonte, A.L., Brown, K.M., **Tryon**, M.D., Monitoring periodic and episodic flow events at Monterey Bay seeps using a new optical flow meter, *Journal of Geophysical Research*, 112, B02105, doi:10.1029/2006JB004410, 2007.
- Géli, L., P. Henry, T. Zitter, S. Dupré, M. **Tryon**, M.N. Çagatay, B. Mercier de Lépinay, X. Le Pichon, AMC Sengor, N. Görür, B. Natalyn, G. Uçarkus, S. Özeren, D. Volker, L. Gasperini, P. Bernard, S. Bourlange, and the Marnaut Scientific Party, Gas emissions and active tectonics within the submerged section of the North Anatolian Fault zone in the Sea of Marmara, *Earth and Planetary Science Letters*, 274 (1-2), 34-39, 2008.
- Tryon**, M.D., Monitoring aseismic tectonic processes via hydrologic responses: An analysis of log-periodic fluid flow events at the Costa Rica outer rise, *Geology*, 37 (2), 163-166, 2009.
- Rathburn, A. E., L. A. Levin, M. **Tryon**, J. M. Gieskes, J. B. Martin, M. E. Pérez F. J. Fodrie, C. Neira, G.J. Fryer, G. Mendoza, P. A. McMillan, J. Kluesner, J. Adamic, W. Ziebis, Geological and biological heterogeneity of the Aleutian margin (2000-4800 m), *Progress in Oceanography*, 80, 22-50, 2009.
- Barry, P.H., D.R. Hilton, M.D. **Tryon**, K.M. Brown, J.T. Kulongoski, A New Syringe Pump Apparatus for the Retrieval and Temporal Analysis of Helium (SPARTAH) in groundwaters and geothermal fluids, *Geology, Geophysics, and Geosystems (G-Cubed)*, (Technical Briefs), doi:10.1029/2009GC002422, 2009.
- Füri, E., D.R. Hilton, K.M. Brown, and M.D. **Tryon**, Helium systematics of cold seep fluids at Monterey Bay, California (USA): temporal variations and mantle contributions, *Geology, Geophysics, and Geosystems (G-Cubed)*, doi:10.1029/2009GC002557, 2009.
- Tryon**, M.D., Wheat, C.G., Hilton, D.R., Fluid sources and pathways of the Costa Rica erosional convergent margin, *Geology, Geophysics, and Geosystems (G-Cubed)*, doi:10.1029/2009GC002818, submitted Aug., 2009b.
- Füri, E., D.R. Hilton, M.D. **Tryon**, K.M. Brown, G.M. McMurtry, W. Brückmann, and C.G. Wheat, Carbon release from submarine seeps at the Costa Rica fore-arc: Implications for the volatile cycle at the Central America convergent margin, *Geology, Geophysics, and Geosystems (G-Cubed)*, submitted Sept., 2009b.

Published or recently submitted meeting abstracts

- Tryon**, M.D., Wheat, C.G., Hilton, D.R., Evidence for subduction of upper plate serpentinite at the western edge of the Caribbean plate, *Eos Trans. AGU*, 90 (53), Fall Meet. Suppl., Abstract XXX-XXX, 2009.
- Brückmann, W., **Tryon**, M.D., Bialas, J., Feseker, T., Lefeldt, M., Monitoring the dynamic properties of an active mud volcano in the West Nile Delta, *Eos Trans. AGU*, 90 (53), Fall Meet. Suppl., Abstract XXX-XXX, 2009.
- Chadwell, C.D., Brown, K.M., **Tryon**, M.D., Send, U., Seafloor horizontal positioning from a continuously operating GPS and acoustic buoy, *Eos Trans. AGU*, 90 (53), Fall Meet. Suppl., Abstract XXX-XXX, 2009.
- Géli L., Henry, P., M.N. Çagatay, M.D. **Tryon**, Luca Gasperini, and MarNaut Science Party, Relations between fluid seepage and seismic activity in the Sea of Marmara, within the submerged section of the North Anatolian Fault, *Eos Trans. AGU*, 90 (53), Fall Meet. Suppl., Abstract XXX-XXX, 2009.
- Fryer, G.J., McMurtry, G.M., Tryon, M.D., Landslide versus splay: The source fo the near-field tsunami of 1 April 1946, *Eos Trans. AGU*, 90 (53), Fall Meet. Suppl., Abstract XXX-XXX, 2009.

- Tryon**, M.D., Observatory-based hydrological and geochemical measurement techniques, ESONET NoE training course on Seafloor Observatory Techniques for Marine Geohazard Monitoring, Istanbul, Turkey, 2009.
- Géli, L., P. Henry, M.N. Çagatay, T Zitter, S. Dupré, M. **Tryon**, B. Mercier de Lépinay, X. Le Pichon, AMC Sengor, N. Görür, S. Özeren, L. Gasperini, J.B. Tary, M. Cevatoglu, S. Bourlange, P. Bernard, J-L. Charlou, and the Marnaut Scientific Party, Relationships between fluid seepage and seismic activity in the Sea of Marmara, 17 August 1999 Izmit Earthquake: 10th Anniversary Symposium, 2009.
- Füri, E., D.R. Hilton, M.D. **Tryon**, and K.M. Brown, Towards Quantifying Volatile Fluxes and Origins from the Costa Rican Fore-Arc Using Novel Submarine Instrumentation, MARGINS TEI Workshop, Oregon, 2009.
- Hilton, D.R., E. Furi, T.P. Fisher, C. Ramirez, M. **Tryon**, P.H. Barry, K. Brown, G. Alvarado, W. Montero, P. Denyer, He-CO₂ characteristics of submarine and subaerial fluids of the Costa Rica forearc, Goldschmidt conference, Switzerland, 2009.
- Tary, J., T. Bardainne, L. Géli, P. Henry, M. Yilmazer, M. **Tryon**, B. Natalin, N. Çagatay, P. Burnard, S. Bourlange, Micro-seismicity of the submerged section of the North-Anatolian Fault within the Sea of Marmara : Results from Ocean Bottom Seismometers, *Eos Trans. AGU*, 89 (53), Fall Meet. Suppl., Abstract T13A-1926, 2008.
- Çagatay, M.N., L. Belucci, A. Polonia, U. Sancar, K. Eris, L. Gasperini, N. Görür, P. Henry, T.A.C. Zitter, L. Géli, M. **Tryon**, Geochemical and Sedimentological Characteristics of the Turbidites Related to Earthquake Activity in the Sea of Marmara, *Eos Trans. AGU*, 89 (53), Fall Meet. Suppl., Abstract U51A-0021, 2008.
- Tryon**, M.D., N. Çagatay, P. Henry, T. Zitter, L. Géli, J-L. Charlou, and Shipboard Scientific Party, Pore fluid chemistry of cold seeps in the Sea of Marmara, Sea of Marmara Workshop, Istanbul Technical University, June 2008.
- Çagatay, M.N., L. Belucci, U. Sancar, A. Polonia, L. Erei, K. Eris, E. Damci, L. Gasperini, N. Görür, P. Henry, T.A.C. Zitter, L. Géli, M. **Tryon**, Sedimentary earthquake records in the Sea of Marmara, Sea of Marmara Workshop, Istanbul Technical University, June 2008.
- Henry, P., Géli, L., T Zitter, S. Dupré, M. **Tryon**, M.N. Çagatay, B. Mercier de Lépinay, X. Le Pichon, AMC Sengor, N. Görür, B. Natalyn, G. Uçarkus, S. Özeren, D. Volker, S. Bourlange, P. Burnard, D. Völker, and the Marnaut Scientific Party, Gas emissions and active tectonics within the submerged section of the North Anatolian Fault Zone in the Sea of Marmara, Geological Society conference “Subsurface sediment remobilization and fluid flow in sedimentary basins”, London, UK, Oct. 2008.
- Henry, P., T.A.C. Zitter, X. LePichon, L. Géli, M.D. **Tryon**, B. Mercier de Lepinay, M.N. Çagatay, A.M.C. Sengor, N. Görür, S. Bourlange, and the Marnaut Scientific Party, Cold seeps in the North Anatolian Fault zone, Sea of Marmara: hints for a deep connection, *Geophysical Research Abstracts*, Vol. 10, EGU2008-A-05747, 2008.
- Çagatay, M.N., L. Belucci, A. Polonia, U. Sancar, D. Dikçe, K. Eris, E. Damci, L. Gasperini, N. Görür, P. Henry, T.A.C. Zitter, L. Géli, M. **Tryon**, Sedimentary earthquake records in the Sea of Marmara, *Geophysical Research Abstracts*, Vol. 10, EGU2008-A-05412, 2008.
- Géli L., Henry, P., S. Dupré, D. Volker, T. Zitter X. LePichon, M.D. **Tryon**, N. Çagatay, and Shipboard Scientific Party, Acoustic detection of gas emissions within the submerged section of the North Anatolian Fault Zone in the Sea of Marmara, *Eos, (Transactions, American Geophysical Union)*, 88 (52), B43E-1659, 2007.
- Henry, P., T. Zitter, X. LePichon, C.A. Sengor, N. Görür, B. Mercier de Lepinay, L. Gasperini, L. Géli, M. **Tryon**, and the Marnaut Scientific Party, Manned submersible observations at cold seeps in the North Anatolian Fault Zone, Sea of Marmara, *Eos, (Transactions, American Geophysical Union)*, 88 (52), B54C-01, 2007.
- Tryon**, M.D., N. Çagatay, P. Henry, T. Zitter, L. Géli, J-L. Charlou, and Shipboard Scientific Party, Pore fluid chemistry of cold seeps in the Sea of Marmara, *Eos, (Transactions, American Geophysical Union)*, 88 (52), B54C-02, 2007.

- Hilton, D.R., G. DeLeew, E. Furi, N. Gulec, H. Mutlu, M.D. **Tryon**, and K.M. Brown, Helium isotope studies in seismically-active regions of Turkey and California, *Geochimica et Cosmochimica Acta*, vol. 71, no. 15S, pp.A406, Aug 2007 (Goldschmidt Conference, Cologne, Germany).
- Furi, E., D.R. Hilton, M.D. **Tryon**, and K.M. Brown, Temporal Control on the Release of Mantle and Crustal Volatiles from Cold Seep Fluids at Monterey Bay, California, USA, in *International Conference on Evolution, Transfer and Release of Magmas and Volcanic Gases*, Academia Sinica, Taipei, Taiwan, 2007.
- Tryon**, M.D., D.R. Hilton, K.M. Brown, G. Wheat, G. McMurtry, W. Brueckmann, H. Niemann, A.L. LaBonte, E. Furi, U. Schacht, and R. Hansman, Observations at forearc carbonate mounds offshore Costa Rica, *Eos, (Transactions, American Geophysical Union)*, 87 (52), V41B-1714, 2006.
- Fryer, G.J., and M.D. **Tryon**, The April Fool's tsunami of 1946: Lessons from Sumatra, *Eos, (Transactions, American Geophysical Union)*, 87 (52), U52A-02, 2006.
- Tryon**, M.D., D.R. Hilton, K.M. Brown, G. Wheat, G. McMurtry, W. Brückmann, A. LaBonte, E. Furi, and A. Thurber, Quantifying elemental fluxes and fluid origins at the Costa Rica forearc using novel submerging instrumentation. *Deep Submergence Science Committee and Western Society of Naturalists Annual Meeting*, Seattle, WA, Nov. 2006.
- Hilton, D.R., E. Furi, M.D. **Tryon**, A.L. LaBonte, and K.M. Brown, Towards developing the capability for near-continuous sampling and storage of helium in geothermal fluids from regions of crustal unrest, in *4th Mini Conference on Noble Gases in the Hydrosphere and in Natural Gas Reservoirs*, pp. 54-56, Potsdam, Germany, 2006.
- Brown, K.M., DeShon, H.R., **Tryon**, M.D., Dorman, L.M., Schwartz, S.Y., Episodic creep, tremor, and fluid expulsion at the updip edge of the seismogenic zone, Costa Rica, *Geophysical Research Abstracts*, 8 (07867), 2006 (EGU meeting).
- Fryer, G.J., and M.D. **Tryon**, Great earthquakes, gigantic landslids, and the continuing enigma of the April Fool's tsunami of 1946, *Eos Trans. AGU*, 86 (52), T11A-0355, 2005.
- Tryon**, M.D., and K.M. Brown, Observations of hydrotectonic stress/strain events at a basement high at the Nicoya outer rise, *Eos Trans. AGU*, 86 (52), T33A-0516, 2005.
- Furi, E., D.R. Hilton, K.M. Brown, and M.D. **Tryon**, Helium and Carbon Isotope Systematics of Cold Seep Fluids at Monterey Bay (California, USA), *Eos Trans. AGU*, 86 (52), V13C-0563, 2005.
- Adamic, J.F., Kluesner, J.W., Rathburn, A.E., Perez, M.E., Basak, C., Levin, L., Gieskes, J.M., Martin, J., Ziebis, W., **Tryon**, M., Comparisons of vertical distribution patterns of living (stained) benthic foraminifera from the Aleutian margin, *Geological Society of America Annual Meeting*, Salt Lake City, Oct. 2005.
- Hilton, D.R., de Leew, G.A.M., Güleç, N., Mutlu, H., Furi, E., Kulongoski, J., Brown, K., **Tryon**, M., Recent helium isotope studies in seismically-active regions: results from the San Andreas Fault Zone, California and the North Anatolian Fault Zone, Turkey, *International Congress on Gas Geochemistry*, Sicily, Oct. 2005.
- Levin, L., Rathburn, A., **Tryon**, M.D., Lonsdale, P., Escobar, E., Gutierrez, D, Gallardo, V., Sellanes, J., Quiroga, E., Stress and strain on eastern Pacific Margin: the biology of newly explored oxygen minimum zone and methane seep ecosystems, submitted. June, 2005 *TOS meeting in Paris - Open Ocean Exploration Session*.
- Rathburn, A.E., Levin, L.A., Gieskes, J.M., Ziebis, W., Martin, J.B., **Tryon**, M.D., Fryer, G.J., McMurtry, G.M., Perez, M.E., Fodrie, J., Bahls, A., Abriani, M., Wrightsman, B., Adamic, J., McMillan, P.A., Neira, C.E., Mendoza, G.F., Leddick, J.E., Do, J., 2004. Of Tsunamis and Seafloor Dynamics: Initial Results of Research Off the Aleutian Islands, Alaska. *Joint Meeting of the 15th Annual Argonne Symposium and CSUI*, November 2004, Chicago, IL, I-5.
- Dorman, L.M., DeShon, H.R., **Tryon**, M.D., Brown, K.M., Schwartz, S., and **Tryon**, M.D., 2004, Seismic Noise Correlation with Seismicity and Fluid Flow: *Eos Trans. AGU*, v. 85(47), Fall Meet. Suppl., Abstract S51B-0150
- Brown, K.M., **Tryon**, M.D., DeShon, H.R., Dorman, L.M., and Schwartz, S., 2004, Transient Fluid Pulsing and Seismic Tremor-like Seismic Noise: Episodic Creep and/or Fluid Expulsion at the

- Updip Edge of the Seismogenic Zone, Costa Rica: *Eos Trans. AGU*, v. 85(47), Fall Meet. Suppl., Abstract S41D-08
- Tryon**, M.D., LaBonte, A.L., Fueri, E., Hilton, D.R., and Brown, K.M., 2004, Toward long-term geochemical sampling of gases and deep fluids in subduction zone fore-arcs: New instrument developments: *Eos Trans. AGU*, v. 85(47), Fall Meet. Suppl., Abstract V13A-1440
- Tryon**, M.D., Brown, K.M., Long-term fluid flow measurements from widely varied oceanic settings elucidate near-surface hydrologic environments, *Eos, (Transactions, American Geophysical Union)*, 84 (46), 846, 2003.
- Brown, K.M., DeShon, H., **Tryon**, M.D., Dorman, L., and Schwartz, S., Transient fluid pulsing and noise in the Costa Rican subduction zone: Nearly silent slip events?, *Eos, (Transactions, American Geophysical Union)*, 84 (46), 1420, 2003.
- Brown, K.M., M.D. **Tryon**, H. DeShon, L. Dorman, and S. Schwartz, Transient fluid flow processes in margin settings: Earthquakes and pulsing in the Costa Rican subduction zone, in *Ocean Margin Research Conference*, Paris, 2003.
- Tryon**, M.D., Brown, K.M., Aqueous flux measurements at the Bush Hill hydrate mound, Gulf of Mexico, *Oceans 2003 Conference*, San Diego, CA., 2003.
- Iwase, R., Machiyama, H., Soh, W., Brown, K.M., **Tryon**, M.D., Detailed mapping of subbottom temperature gradient and flow rate observation at the seepage site on deep seafloor off Hatsushima Island in Sagami Bay, central Japan, *IUGG Conference*, 2003.
- Torres, M.E., J. McManus, M. deAngeles, M.D. **Tryon**, A. Trehu, K.M. Brown, and D. Hammond, Benthic fluxes from sediments hosting methane hydrate deposits at Hydrate Ridge, Cascadia, in *Abstracts with Programs - Geological Society of America*, 34 (5), pp.42, Apr 2002.
- Tryon**, M.D., C. Mahn, J. Gieskes, and K.M. Brown, Methods of fluid and geochemical flux measurements and new insights from seep studies at the Eel River Margin, *Eos, (Transactions, American Geophysical Union)*, 82 (48), 1302, 2001.
- Tryon**, M.D., and K.M. Brown, Results from long-term aqueous flux measurements on the Costa Rican convergent margin, *Eos, (Transactions, American Geophysical Union)*, 81 (48), 1161, 2000.
- Tryon**, M.D., Brown, K. M., The Chemical and Aqueous Transport meter; A benthic flux meter for long term monitoring of low to moderate flow rates: *RIDGE in situ Workshop*, Aptos, CA, 2000.
- Brown, K.M., and M.D. **Tryon**, Could temporal changes in fluid expulsion patterns from cold seep regions located on faults be used to monitor transient stress changes in the seismogenically coupled region of the subduction thrust?, *Special Paper – Oregon, Department of Geology and Mineral Industries*, 33, 33-34, 2000.
- Tryon**, M.D., and K.M. Brown, Transient fluid flow patterns on Hydrate Ridge, Cascadia: A response to methane gas discharge?, *Eos, (Transactions, American Geophysical Union)*, 80 (46), 528, 1999.
- Tryon**, M.D., and K.M. Brown, Aqueous flux measurements on Hydrate Ridge, Cascadia, in *Pacific Section Convention, Program with Abstracts*, pp. 45, American Association of Petroleum Geologists, Monterey, California, 1999.
- Brown, K.M., C. Goldfinger, G. Bohrmann, M. Torres, M. **Tryon**, C. Jung, E. Suess, H. Sahling, and A.M. Trehu, Geological and Hydrogeologic Interrelationships Around Seep and Gas Vent Regions on Hydrate Ridge: Seabed Observations, *Eos, Transactions, American Geophysical Union*, 80 (46), 1999.
- Linke, P., O. Pfannkuche, M.E. Torres, R.W. Collier, U. Witte, J. McManus, D.E. Hammond, K.M. Brown, M.D. **Tryon**, and K. Nakamura, Variability of benthic flux and discharge rates at vent sites determined by in situ instruments, *Eos, Transactions, American Geophysical Union*, 80 (46), 509, 1999.
- Torres, M.E., K. Brown, S. Colbert, R.W. Collier, M. deAngelis, D. Hammond, K. Heeschen, D. Hubbard, J. McManus, C.L. Moyer, G. Rehder, A. Trehu, M.D. **Tryon**, and P.J. Whaling, Active gas discharge resulting from decomposition of gas hydrates on Hydrate Ridge, Cascadia Margin, *Eos (Transactions, American Geophysical Union)*, 79 (45), 461, 1998.

- Tryon**, M.D., K.M. Brown, and D. Elliott, Instrument development and results from sea floor flux meter deployments off California and Oregon, *Eos (Transactions, American Geophysical Union)*, 78 (46), 690, 1997.
- Tryon**, M.D., K.M. Brown, L.M. Dorman, and A.W. Sauter, Instrument Development and Results From Sea Floor Flux Meter Deployments Off N. California and the EPR, *Eos (Transactions, American Geophysical Union)*, 77 (46), 236, 1996.
- Brown, K.M., T.G. Fitts, M.D. **Tryon**, and B. Ransom, An experimental study of the physical and chemical property changes occurring during the smectite to illite reaction, *AAPG Meeting Abstracts*, 5, 19, 1996.
- Fitts, T.G, K.M. Brown, M.D. **Tryon**, and B. Ransom, Measurement of porosity and smectite hydration state under deviatoric stress conditions; implications for water partitioning between pores and minerals in sedimentary basins, *AAPG Meeting Abstracts*, 5, 46, 1996.
- Fitts, T.G, K.M. Brown, M.D. **Tryon**, Gradual vs instantaneous dewatering of smectites; experimental data and implications for physical properties of smectite-rich sediments in nature, *AAPG Meeting Abstracts*, 5, 89, 1996.
- Fitts, T.G, K.M. Brown, M.D. **Tryon**, Smectite diagenesis; preliminary experimental results and implications for the development of overpressuring during the burial of smectite-rich sediments, *Eos, Transactions, American Geophysical Union*, 76 (46), 189, 1995.

Manuscripts in progress

- Tryon**, M.D., P. Henry, Géli, L., M.N. Çagatay, L. Gasperini, T Zitter, P. Bernard, S. Bourlange, S. Dupré, B. Mercier de Lépinay, X. Le Pichon, AMC Sengor, N. Görür, B. Natalyn, S. Özeren, and the Marnaut Scientific Party, The extreme diversity of pore fluid chemistry at fault zone cold seeps in the Sea of Marmara, in prep, 2009c.
- Tryon**, M.D., A new evaluation of the boron chemistry of the Mariana mud volcanoes: Evidence for subduction erosion, in prep, 2009d.

CURRENT ACTIVITIES - 2009

My research over the past year has been divided between two field projects, two instrument development projects, and final synthesis and manuscript preparation for an earlier field project. The MARNAUT Project is an international collaboration utilizing a wide array of geophysical and hydrological techniques to study the manifestations of fluid expulsion associated with the Main Marmara Fault, the submerged western extension of the North Anatolian Fault Zone in Turkey, with the theme of understanding the relationship between seismic activity and fluid migration/expulsion processes along this active plate boundary. Our results confirm a direct relationship between seafloor faults and water and gas emissions with active expulsion tied to earthquake activity and seismic gaps associated with a lack of expulsion (Géli et al., 2008). The main strike-slip fault intersects fluid sources many kilometers below the seafloor and provides a pathway for oil and thermogenic gas as well as formation fluids with high salinities and exotic chemistry. Extensional tears in the NW Tekirdag Basin expel plumes of CO₂ rich in mantle ³He. Basin boundary extensional faults intersect near-surface sources of methane and buried Pleistocene Lake Marmara water (Tryon et al., 2007, 2009c).

Mud volcanism is a common phenomenon in different continental margin settings, especially in deltaic depositional systems worldwide. Fluid formation and fluidization processes occurring at depths of several kilometers below the seafloor can be monitored in mud volcanoes acting as

natural leakages for oil and gas reservoirs. To gain a better understanding of deep processes occurring in the West Nile Delta area, I am carrying out a study on two mud volcanoes in collaboration with IFM-GEOMAR as part of The West Nile Delta Project. This project focuses on qualifying the chemical and isotopic composition of pore fluids as well as investigations of light volatile hydrocarbon gases and organic biomarkers and the quantification of the variability of dewatering and degassing through long-term flow rate and chemical flux measurements. Deployments of flow meters, gas and fluid samplers, pore pressure sensors, and heat flow surveys were done in Fall 2008 and the instruments will be recovered in November 2009.

I also have two instrument development projects ongoing. The first of these is the development of an ocean bottom 3-D strain meter, "GEOCE", in collaboration with K. Brown, D. Chadwell, and U. Send, all at Scripps. My portion of this project uses high resolution pressure measurements and a seafloor pressure standard to determine the vertical motion of the seafloor in response to tectonic deformation and/or gravitational sliding. The data we are receiving from the shallow engineering deployment off Torrey Pines is indicating we are near to achieving the goal of 1 cm resolution in 3 dimensions. A final deep test deployment is due early 2010. My second instrumentation project is the development of a new generation of seafloor piezometers for both long-term monitoring of the hydrological response to tectonic strain and for geotechnical investigations. Design, modeling, and electronic prototyping is nearly completed and a final instrument is expected to be ready to deploy in early 2010. These two instrumentation development programs will allow us to monitor the most critical properties (stress and strain) of continental margins to improve our understanding of the underlying tectonics and for evaluation of their potential for catastrophic failure.

The margins community has only relatively recently begun to examine the substantially different tectonics and associated hydrologic systems of erosive convergent margins as compared with accretionary margins. One type example is the Costa Rica system which has been the subject of numerous recent large-scale investigations as well as our 2005-2007 investigations at mid-slope mud volcanoes Mound 11 and 12 and at Jaco Scar. Pore fluids expelled at the wedge toe and at these mud volcanoes have been previously interpreted to have the same deep source of dehydrating clays however our investigations indicate they have boron and lithium concentrations and ratios that differ by orders of magnitude and are incompatible with this explanation. Our analyses suggest that the fluid chemistry, and particularly the extremely high B/Li molar ratios, seen at a recent mud flow on Mound 11 is the result of a fluid source rich in eroded material from the serpentinized upper plate that has been subducted to higher temperatures and released excess B into the pore fluids. Serpentine formation is the only common subduction zone process that significantly fractionates B and Li. This conclusion is compatible with and supported by the newly emerging view of the tectonics, geology, and hydrogeology of this erosive margin and the similarity of the pore fluid to that at two other convergent margins with known serpentinite (Tryon et. al, 2009b).