

Facts and Situation Status of Arsenic in Rice

Christopher A. Greer

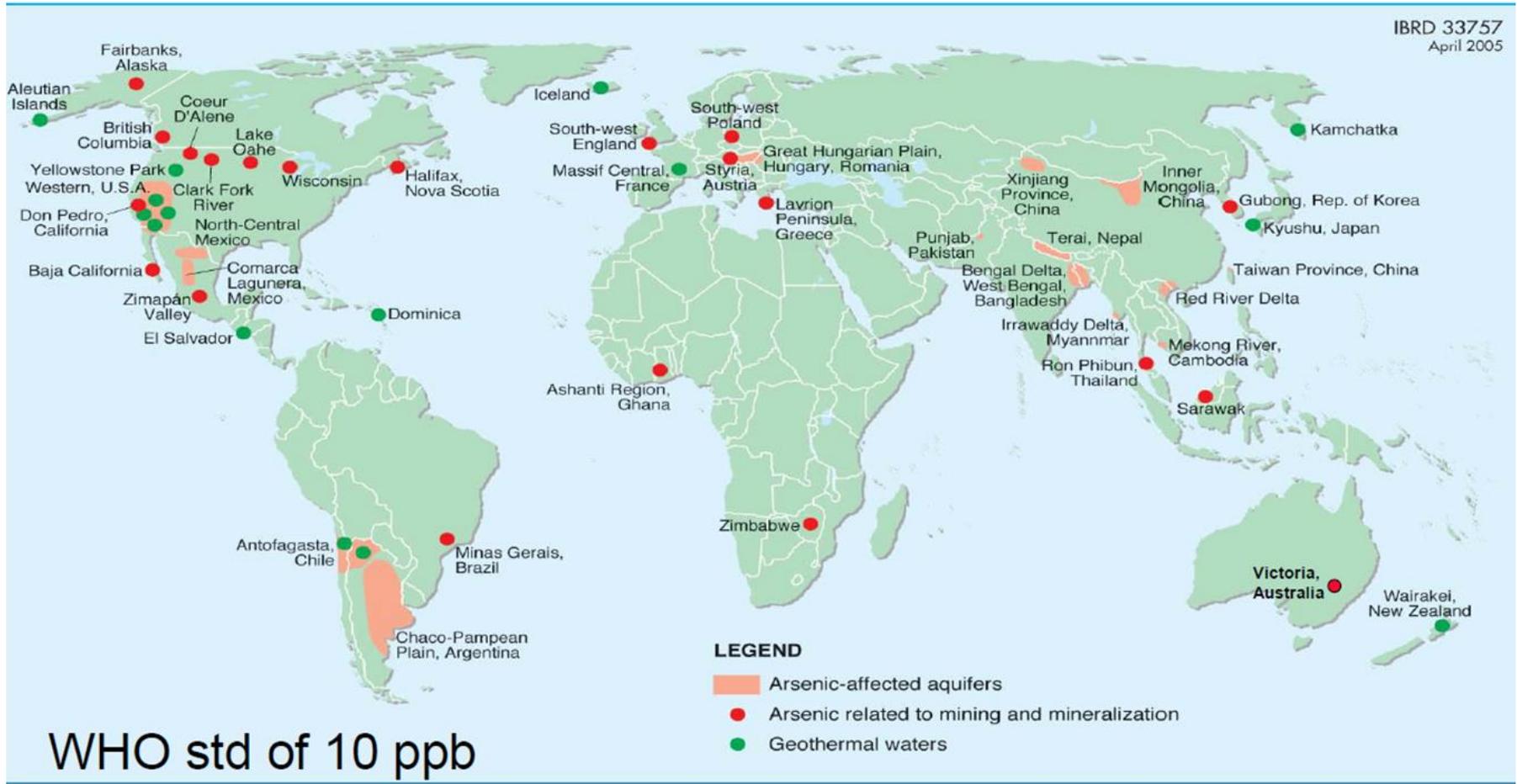
SJC and Delta Rice Growers Meeting

February 25, 2013

Arsenic

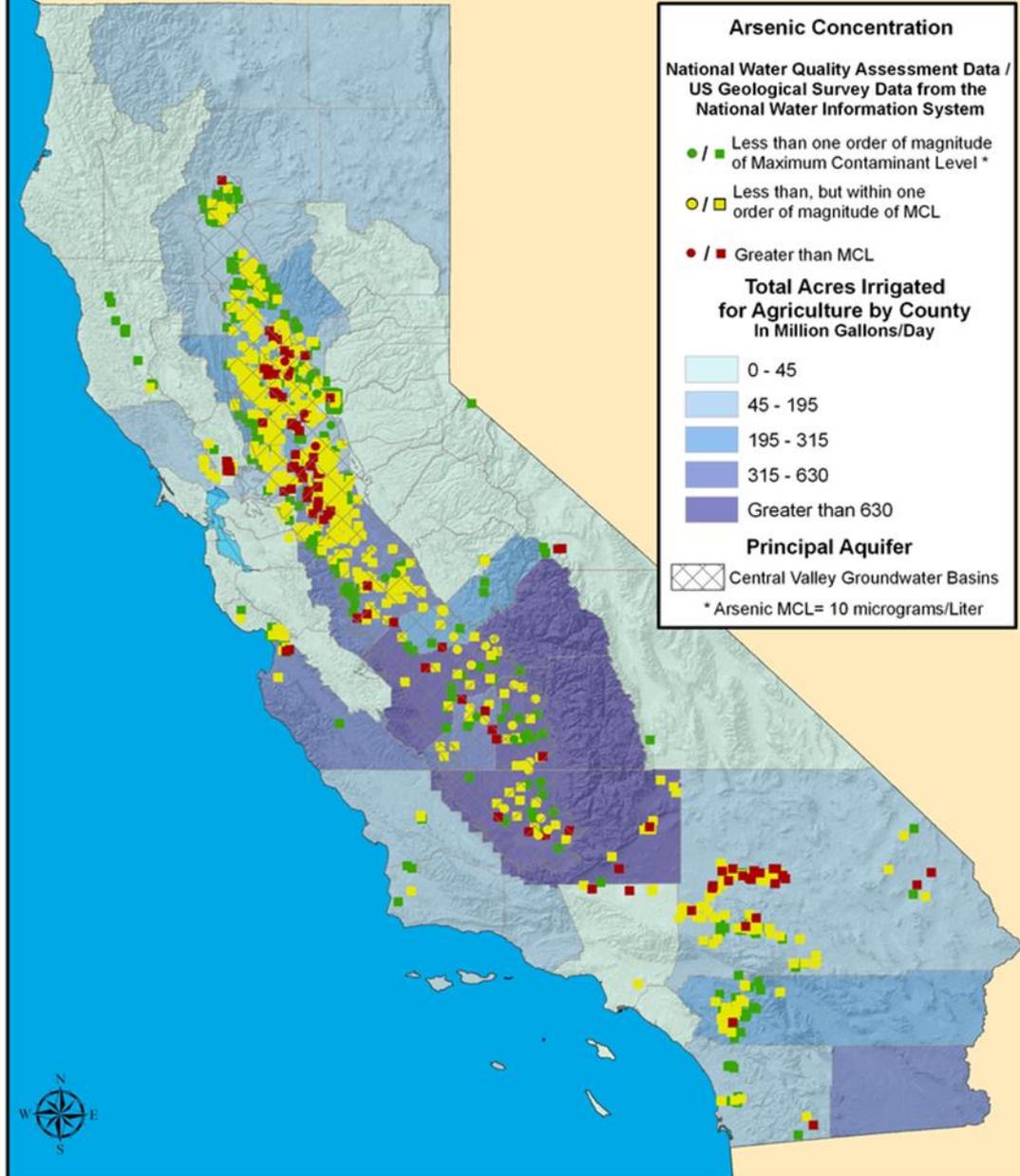
- Inorganic and organic arsenic occur naturally in the environment
- Inorganic arsenic is associated with other metals in igneous and sedimentary rocks
- Organic arsenic contains carbon and hydrogen
- Both inorganic and organic forms exist naturally in soils, plants, animals, and humans

Arsenic in Water is a Global Environmental and Health Issue



Source: World Bank Water and Sanitation Program, 2005

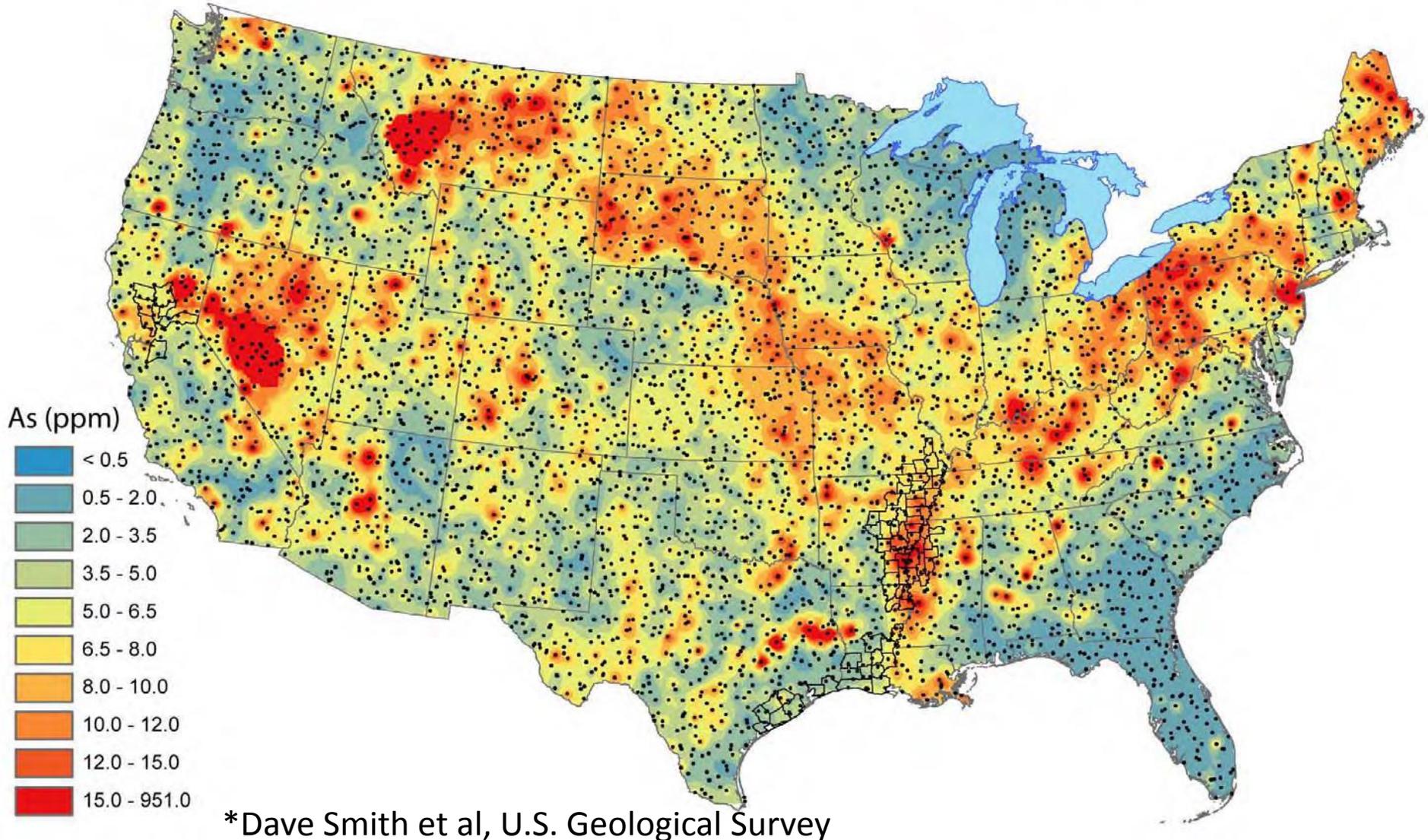
Arsenic Contamination in Domestic Groundwater Wells and Agricultural Irrigation



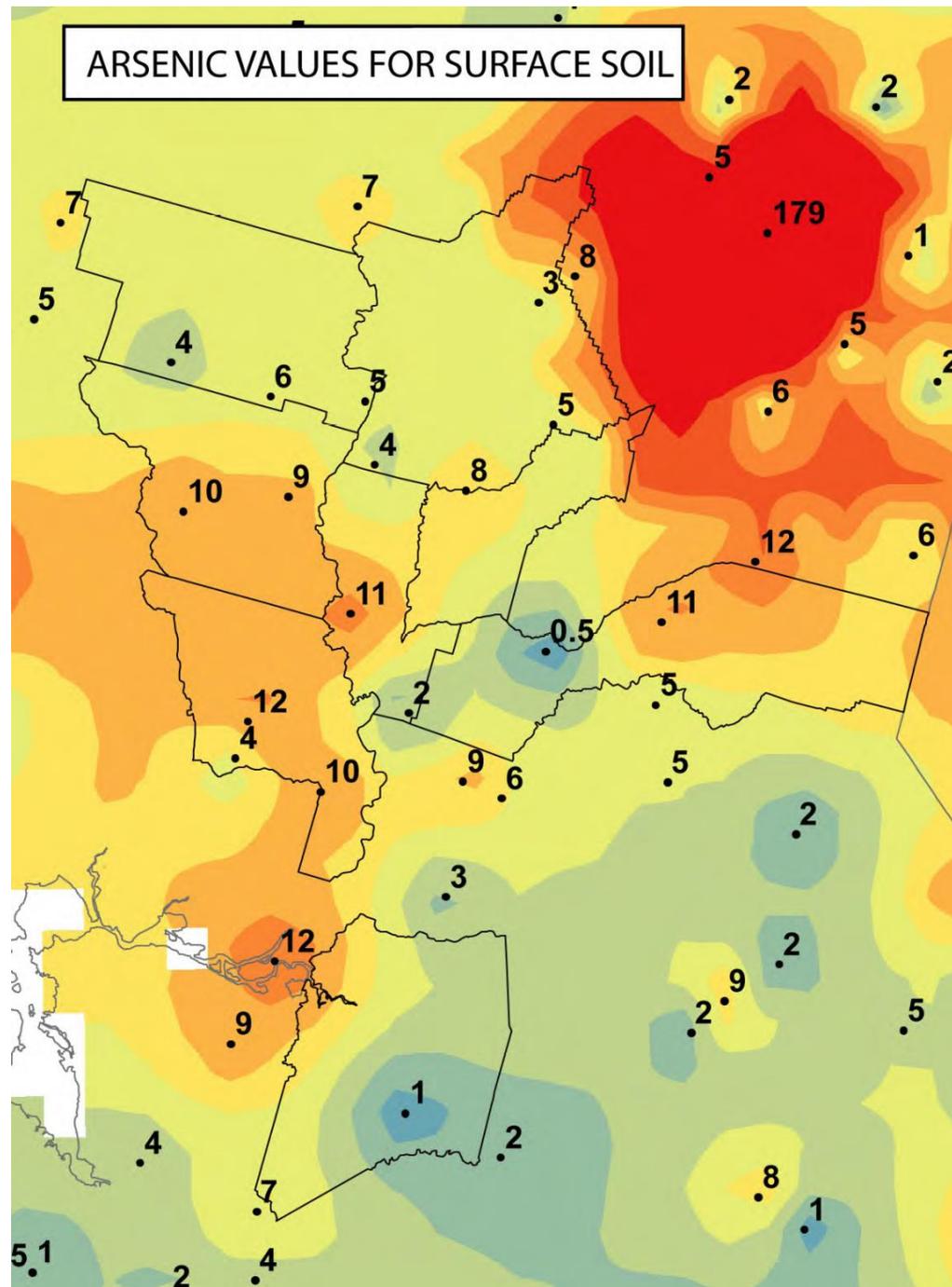
Arsenic in Drinking Water

- Generally as the inorganic form
- Mixture of arsenite (As, III) & arsenate (As, V)
- Standard for drinking water = 10 ug/L based on cancer risk
- No standard for intake of As from food

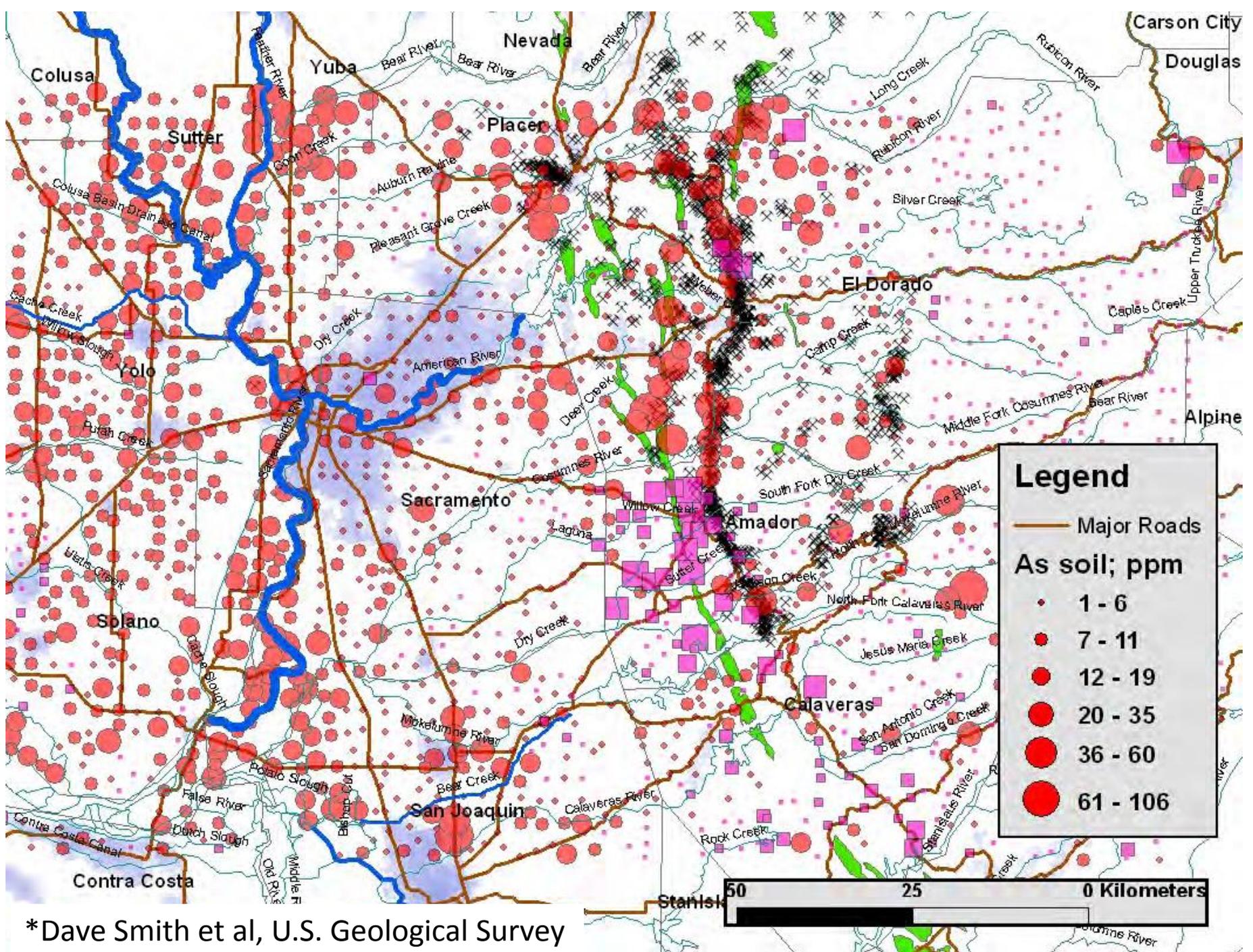
ARSENIC IN SURFACE (0-5 CM) SOIL



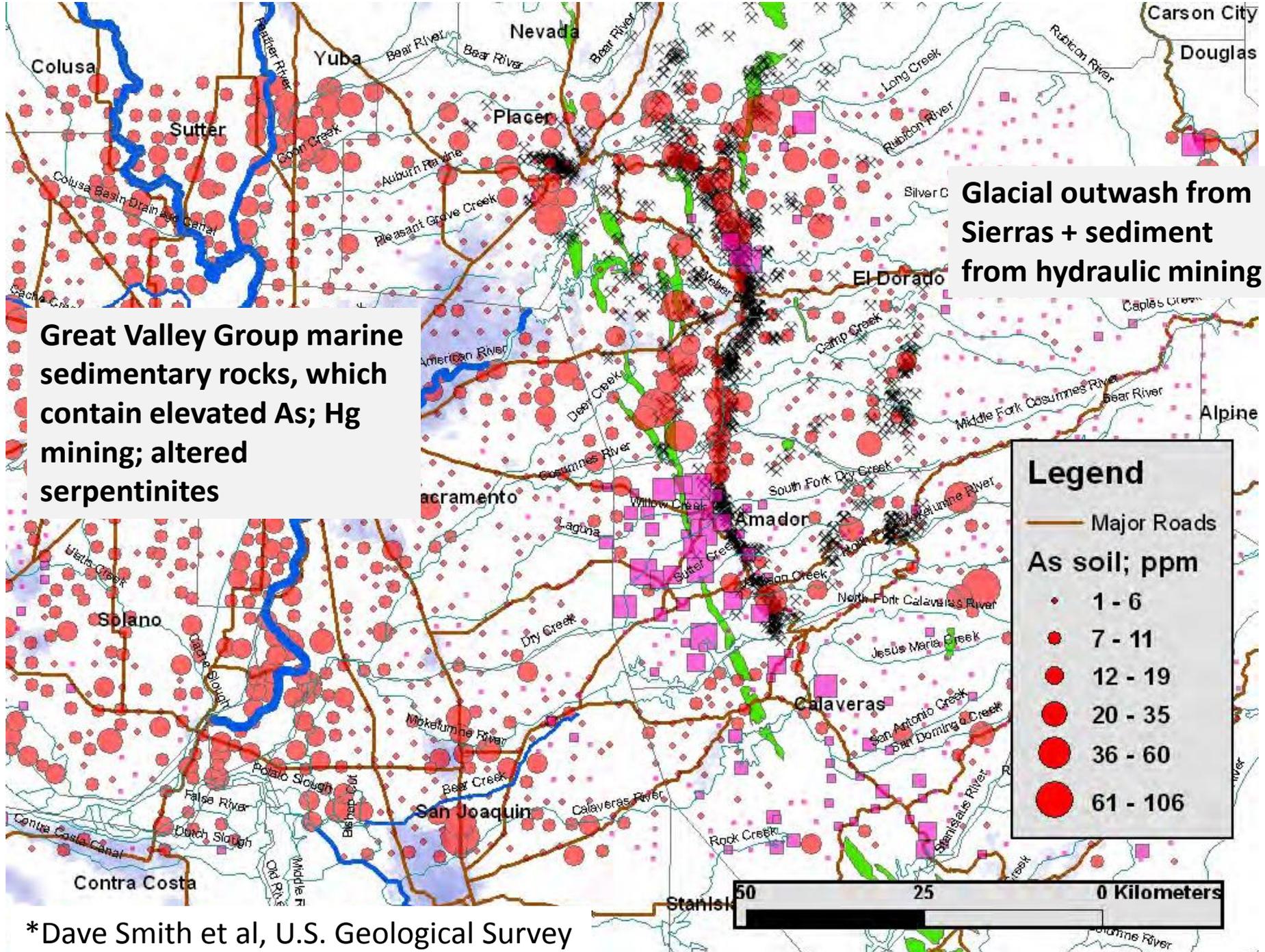
Arsenic in rice-growing region of northern California



*Dave Smith et al,
U.S. Geological Survey



*Dave Smith et al, U.S. Geological Survey



Glacial outwash from Sierras + sediment from hydraulic mining

Great Valley Group marine sedimentary rocks, which contain elevated As; Hg mining; altered serpentinites

Legend

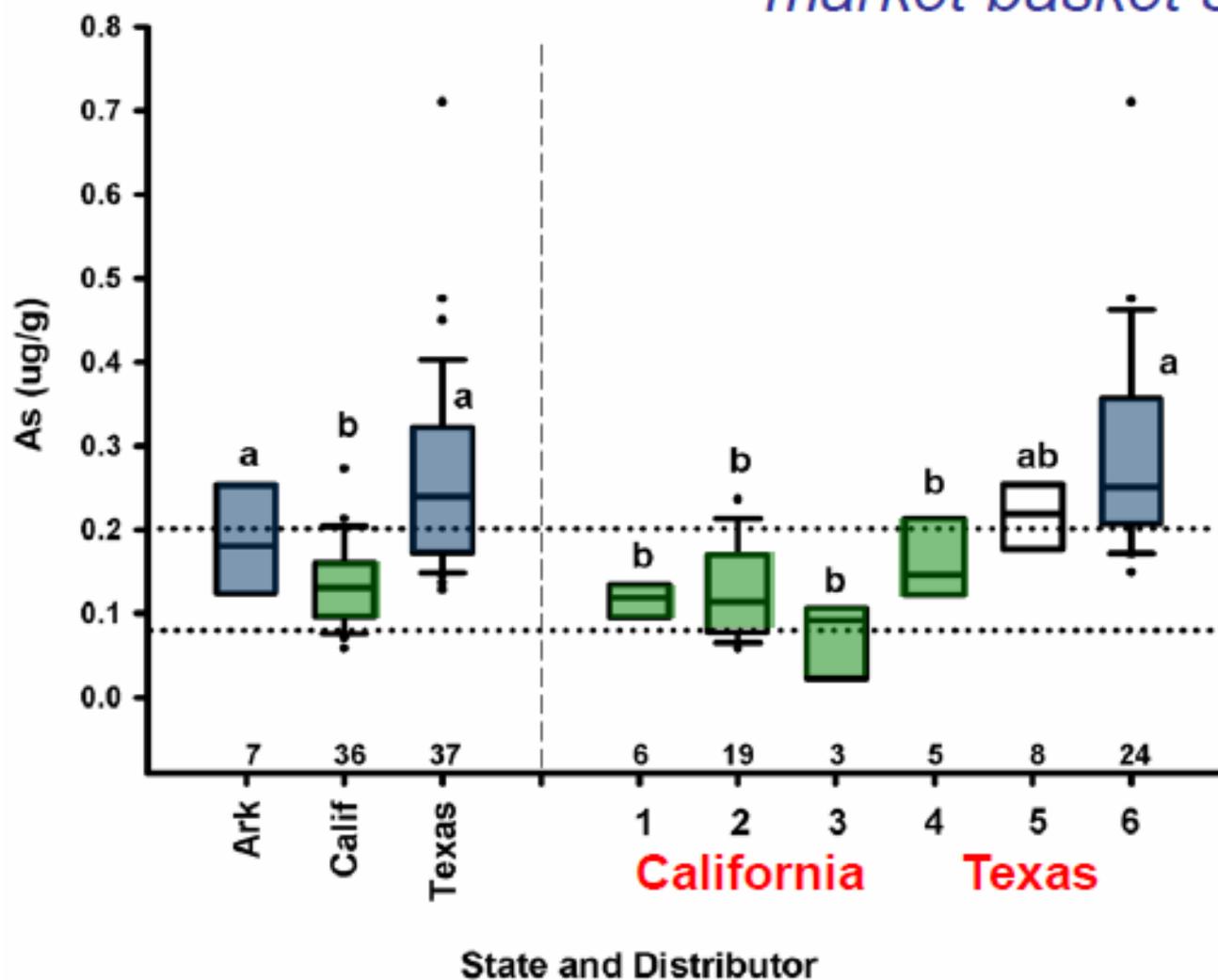
— Major Roads

As soil; ppm

- 1 - 6
- 7 - 11
- 12 - 19
- 20 - 35
- 36 - 60
- 61 - 106

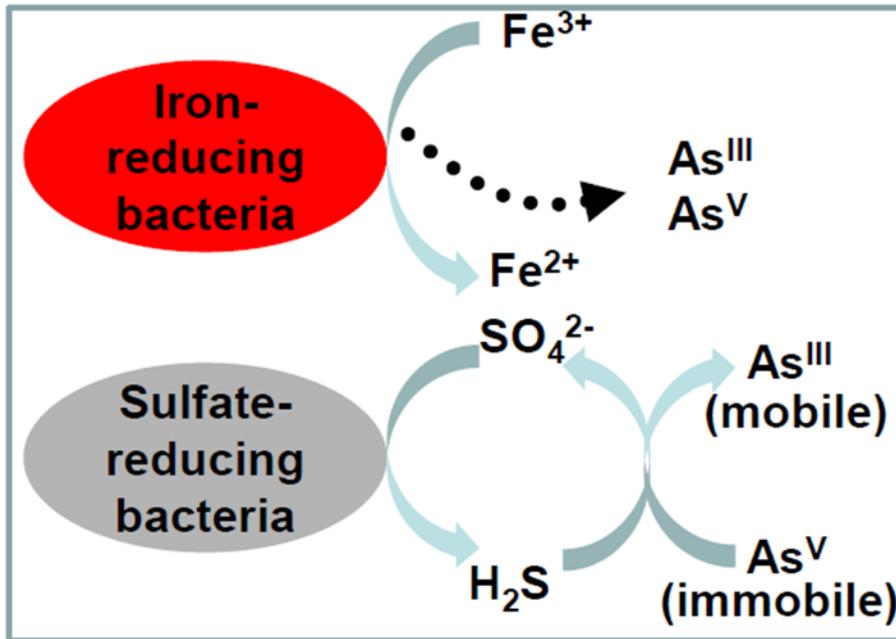
*Dave Smith et al, U.S. Geological Survey

market basket survey

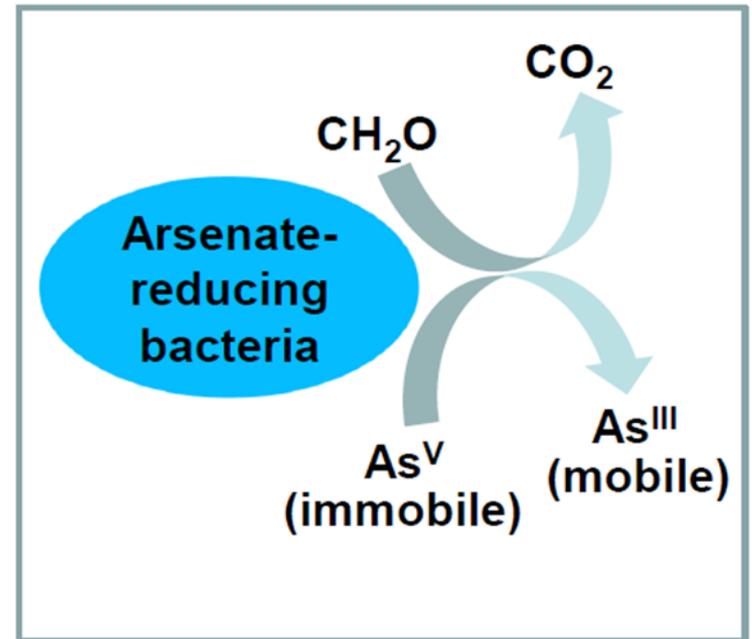


Indirect & Direct Microbial Mobilization of Arsenic

Indirect As mobilization



Direct As mobilization



- Arsenate-reducing bacteria can also use other compounds as electron donors (e.g. *Sulfurospirillum* spp. & sulfides)

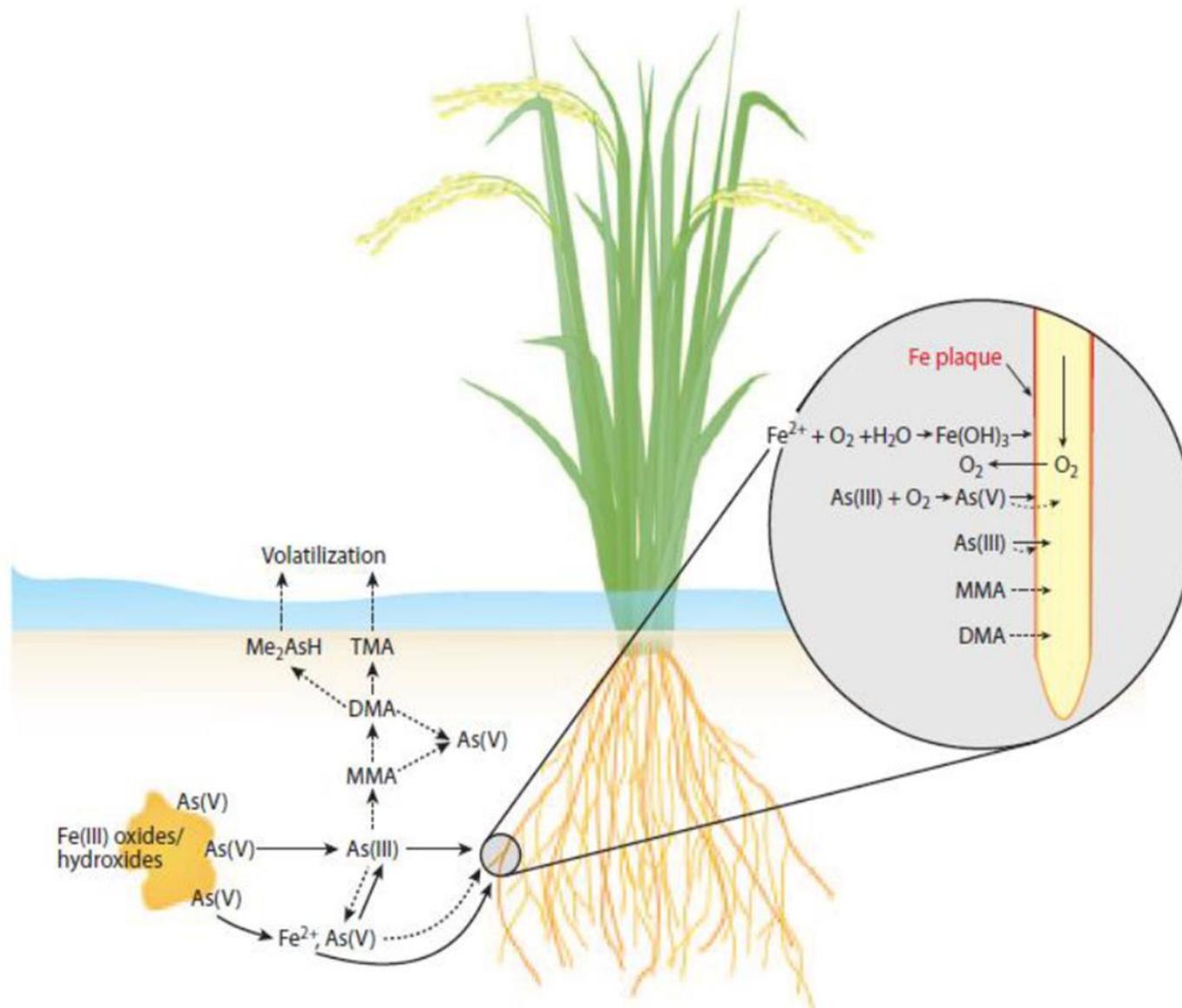


Figure 1

Arsenic mobilization and transformation in flooded paddy soil and interactions in the rice rhizosphere. Arrows with solid and broken lines indicate dominant and minor processes, respectively.

Zhao et al. (2010)

Dartmouth Studies - Arsenic in Rice

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Dartmouth Researchers Evaluate Rice as a Source of Fetal Arsenic Exposure

POSTED ON DECEMBER 5, 2011 BY JOSEPH BLUMBERG



A study just published by a Dartmouth team of scientists in the *Proceedings of the National Academy of Sciences (PNAS)* advances our understanding of the sources of human exposure to arsenic and focuses attention on the potential for consuming harmful levels of arsenic via rice.



Dartmouth Researchers (from left) Carol Folt, Diane Oberst-Diamond, Margaret Koenigs, and Hillary Coughlin review study data. (photo by Bill Bural '10)

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Rice Arsenic Exposure During Pregnancy November 2011

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Organic Food Sweetener May Be a Hidden Source of Dietary Arsenic

POSTED ON FEBRUARY 10, 2012 BY JOSEPH BLUMBERG



As people seek healthier dietary regimens they often turn to things labeled "organic." Lurking in the background, however, is an ingredient that may be a hidden source of arsenic—an element known to be both toxic and potentially carcinogenic.



Professor Brian Jackson is director of the Trace Element Analysis Core Facility at Dartmouth.

Organic brown rice syrup has become a preferred alternative to using high fructose corn syrup as a sweetener in food. High fructose corn syrup has been criticized as a highly processed substance that is more harmful than sugar and is a substantial contributor to epidemic obesity. Unfortunately, organic brown rice syrup is not without its faults.

Dartmouth researchers and others have [previously called attention to the potential for consuming harmful levels of arsenic](#) via rice, and organic brown rice syrup may be the latest culprit on the scene.

With the introduction of organic brown rice syrup into food processing, even the savvy consumer may unknowingly be ingesting arsenic. Recognizing the danger, [Brian Jackson](#) and other Dartmouth researchers conducted a study to determine the concentrations of arsenic in commercial food products containing organic brown rice

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Organic Brown Rice Syrup (OBRS) Feb. 2012

Rice Arsenic Media Coverage

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FOOD & BEVERAGE
New study focuses on arsenic in rice
 Oct. 11, 2012 10:46 AM

After the widely publicized study of more than 200 pregnant women receiving prenatal care in the New Hampshire area reports a link between rice consumption and elevated levels of arsenic in urine, suggesting that "heavy doses" at the United States may be exposed to potentially harmful levels of arsenic through rice consumption," according to the abstract by researchers at Dartmouth's Children's Environmental Health and Disease Prevention Center.

"The study was statistically significant association was obtained between rice consumption and arsenic levels, in addition to earlier reports of elevated arsenic concentrations in rice, highlights the need to regulate arsenic in food," writes the authors of the study, which was published in the peer-reviewed journal *Proceedings of the National Academy of Sciences*.

There are no statutory limits for arsenic in methicillin used in the U.S. and the European Union.

Based on a **Consumer Reports** recent panel poll, including tests which found elevated levels of arsenic and lead in samples of apple juice and grape juice, **Consumer Union**, the division of **Consumer Reports**, which has called on the federal government to set legally binding standards in terms of lead, total arsenic, and 5-phenol, and to take steps that would reduce other dietary exposures to arsenic. Our investigation included an analysis of methicillin health data that also revealed a link between apple juice consumption and high levels of total arsenic arsenic.

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FOOD SAFETY
New study finds arsenic in infant formula, cereal bars
 Feb. 16, 2012 10:46 AM

Arsenic has been found in some foods that use organic brown rice syrup as a sweetener, including infant formula and cereal bars, according to a new study by researchers of Dartmouth College. The majority of the detected arsenic, a controversial toxin found in rice, was the type that is known to be a human carcinogen.

Important findings of the study, published online Feb. 16 by the peer-reviewed journal *Environmental Health Perspectives* include:

- Two of 17 infant formula tested listed organic brown rice syrup as the primary ingredient. One had a total arsenic concentration that was six times the federal limit of 10 parts per billion (ppb) for total arsenic in bottled or public drinking water. This is particularly worrisome for babies because they are especially vulnerable to arsenic's toxic effects due to their small size and the corresponding arsenic consumption per pound of body weight.
- Twenty-two of 20 cereal bars or energy bars tested listed at least one of these four rice products—organic brown rice syrup, rice flour, rice grain or rice flakes—among the top five ingredients. The seven other bars were among the lowest in total arsenic, ranging from 8 to 17 ppb, while those containing syrup or other forms of rice ranged from 23 to 126 ppb.
- Tests of high-energy protein bars, rice cereal, and other products that are eaten by endurance athletes and others showed that one of the three gas-like toxins contained the top of total arsenic, while the other two contained 1.71 ppb.

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Organic Is Good, But Arsenic Contamination Is Still a Threat

By **Wendell Hester**

Lots of people were shocked to hear about a recent study that found arsenic in foods made with organic brown rice syrup. But this is not a problem that's related to a specific ingredient, or to organic food. As Dr. Oz's team knew, concerns about arsenic contamination have been ongoing in different sections of the grocery store — in apple juice, the most case (arsenic has been tied to chickens for decades), and now in the processed food aisle.

When it comes to a problem like arsenic contamination in food, there's no quick solution for consumers. Consumers can't see, taste or smell if arsenic is in their food. This new report about processed foods containing organic brown rice syrup offers just the latest example of why consumers need the government to set standards for arsenic levels in food.

The recent study focused on processed foods like cereal bars, "high energy foods" used by athletes, and infant formula that use organic brown rice syrup as a sweetener, often as an alternative to high-fructose corn syrup. The authors pointed to a growing body of research on arsenic contamination in rice, and said they wanted to see if processed foods containing rice-based ingredients were a source of exposure to arsenic. When they tested these foods for arsenic, they found arsenic in many of them.

So, how does arsenic get into food anyway? In the case of chickens, producers sometimes add an arsenic-based drug to chicken feed so that they grow faster and have pinker meat. The arsenic, like chickens ends up in the billions of pounds of poultry waste produced and spread across fields as fertilizer each year, which can contaminate soil and water, and some can stay behind in the chickens themselves.

In apple juice and rice, arsenic gets taken up from the environment by the apple tree or the rice plant. Arsenic might be in the soil naturally or it could be left behind from the use of arsenic-based pesticides, herbicides, and weed control agents. In the United States, many of these arsenic-based chemicals have

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Below you'll find the **Dr. Oz** Summer. Summer has officially arrived. If it wasn't for that, it means backyard barbecues and drinks and

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A Common Organic Sweetener May Boost Arsenic Levels in Foods
 Study Shows Brown Rice Syrup Adds Arsenic to Many Natural, Organic Products

By **Emily Greenman, MS**
WebMD Health News
 Reviewed by **Laura J. Martin, MD**

Feb. 16, 2012 — Organic brown rice syrup, a popular sweetener in organic and gluten-free foods — including some formulas made for babies — is a source of the toxic arsenic, new study shows.

Experts say regularly eating foods that use organic brown rice syrup as a main ingredient could expose a person to more arsenic than the government allows in drinking water, raising the risk for cancer and heart disease. In young children, chronic arsenic exposure has been linked to lower IQ and poorer intellectual function.

"This seems to be quite strong evidence," says **Anna Hertz-Acros, M.D., PhD**, an assistant professor of environmental health sciences and epidemiology at the Johns Hopkins Bloomberg School of Public Health in Baltimore, Md.

"I would personally not buy formula made of brown rice," says **Nancy-Acheson**, who studies the health effects of arsenic; she was not involved in the current research.

Manufacturers insist that their products are safe.

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 SLIDESHOW: 5 Drug by Street Management

Nov. 2011, March 2012 shows and website (Emphasize possible harm to children)

*USA Rice Federation

Product	Origin	Total arsenic (ppb) ^①	Inorganic arsenic (micrograms/serving) ^②
RICE (45 g, about ¼ cup uncooked)			
365 Everyday Value Long Grain Brown (Whole Foods)	③	210 to 282	7.4 to 8.4
365 Everyday Value Organic Indian Basmati White (Whole Foods)	India	82.2 to 99.9	2.9 to 3.5
365 Everyday Value Organic Thai Jasmine White (Whole Foods)	Thailand	104 to 150	2.7 to 3.0
Archer Farms Organic Basmati (Target)	India	54.7 to 81.7	1.3 to 2.2
Archer Farms Organic Jasmine (Target)	Thailand	112 to 121	2.7 to 3.9
Cajun Country Enriched Long Grain	LA	328 to 348	4.8 to 5.2
Cajun Country Popcorn Long Grain	LA	350 to 436	3.9 to 5.3
Canilla Extra Long Grain Enriched	U.S.	198 to 431	3.2 to 7.2
Carolina Enriched Extra Long Grain	AR,LA,TX	144 to 236	3.4 to 4.8
Carolina Jasmine Enriched Thai Fragrant Long Grain	Thailand	119 to 159	3.0 to 3.2
Carolina Whole Grain Brown	AR,LA,TX	277 to 318	6.4 to 8.7
Della Basmati Brown	AR	308 to 568	5.9 to 9.4
Della Basmati White	AR	191 to 227	3.5 to 4.5
Doguet's Brown	U.S.	283 to 342	5.6 to 6.4
Doguet's Enriched Long Grain	U.S.	124 to 219	3.3 to 4.4
Goya Enriched Medium Grain	③	196 to 297	3.8 to 5.1
Great Value Brown (Walmart)	U.S.	212 to 344	5.2 to 6.8
Great Value Parboiled (Walmart)	U.S.	138 to 239	4.1 to 4.4
Jazzmen Louisiana Aromatic Brown	LA	237 to 295	4.7 to 8.6
Jazzmen Louisiana Aromatic White	LA	168 to 209	3.2 to 4.1
Lundberg California White Basmati	CA	64.3 to 75.5	1.3 to 1.6
Lundberg Short Grain Brown	CA	169 to 204	3.8 to 5.4
Mahatma Extra Long Grain Enriched	U.S.	129 to 284	3.4 to 4.9
Market Pantry Enriched Long Grain White			

*Consumer Reports

Comparing the drinking water standard to food, however, is invalid since:

- 1) Nearly 100% of the arsenic in water is the inorganic form and is by virtue of being dissolved in water, readily accessible by the body.
- 2) The amount of exposure to arsenic from water is far greater than from a food source such as rice due to far higher consumption levels for water.

According to toxicologists, rice contributes approximately 3.4 micrograms of inorganic arsenic for a one-half cup serving.

EPA's maximum exposure level using the drinking water standard (2 liters of water per day containing 10 ppb. per liter) is 20 micrograms of inorganic arsenic per day.

English

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ARSENIC IN RICE

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An Online Resource for Information on Arsenic in Rice

MESSAGE FROM AMERICA'S RICE FARMERS

*America's rice farmers and rice companies take pride in giving consumers wholesome, high quality and nutritious rice. We know that arsenic in food is alarming for many consumers and that you may have questions. We also want you to know what steps the rice industry is taking to address concerns raised about arsenic in rice. **The rice industry supports the process by which FDA is moving forward with its sampling and scientific investigation and is fully cooperating with FDA.***

FDA Looks at Arsenic in Rice

The FDA is in the process of collecting and analyzing a total of approximately 1,200 samples to examine the issue thoroughly. This data collection will be completed soon. Once the data collection is completed, FDA will analyze these results and determine whether or not to issue additional recommendations.

HERE'S WHAT YOU NEED TO KNOW

- FDA STATEMENT ON ARSENIC AND RICE
- FACTS ABOUT ARSENIC IN RICE - OCTOBER 2012
- CODEX REPORT: US RICE HAS LOWEST INORGANIC ARSENIC OF ALL COUNTRIES SURVEYED
- AMERICAN ACADEMY OF PEDIATRICS STATEMENT
- INFORMACIÓN EN ESPAÑOL



“It is critical to not get ahead of the science,” said FDA Deputy Commissioner for Foods Michael Taylor. “The FDA's ongoing data collection and other assessments will give us a solid scientific basis for determining what action levels and/or other steps are needed to reduce exposure to arsenic in rice and rice products.”

The FDA is in the process of collecting and analyzing a total of approximately 1,200 samples to examine the issue thoroughly. This data collection will be completed by the end of 2012. Once the data collection is completed, FDA will analyze these results and determine whether or not to issue additional recommendations.

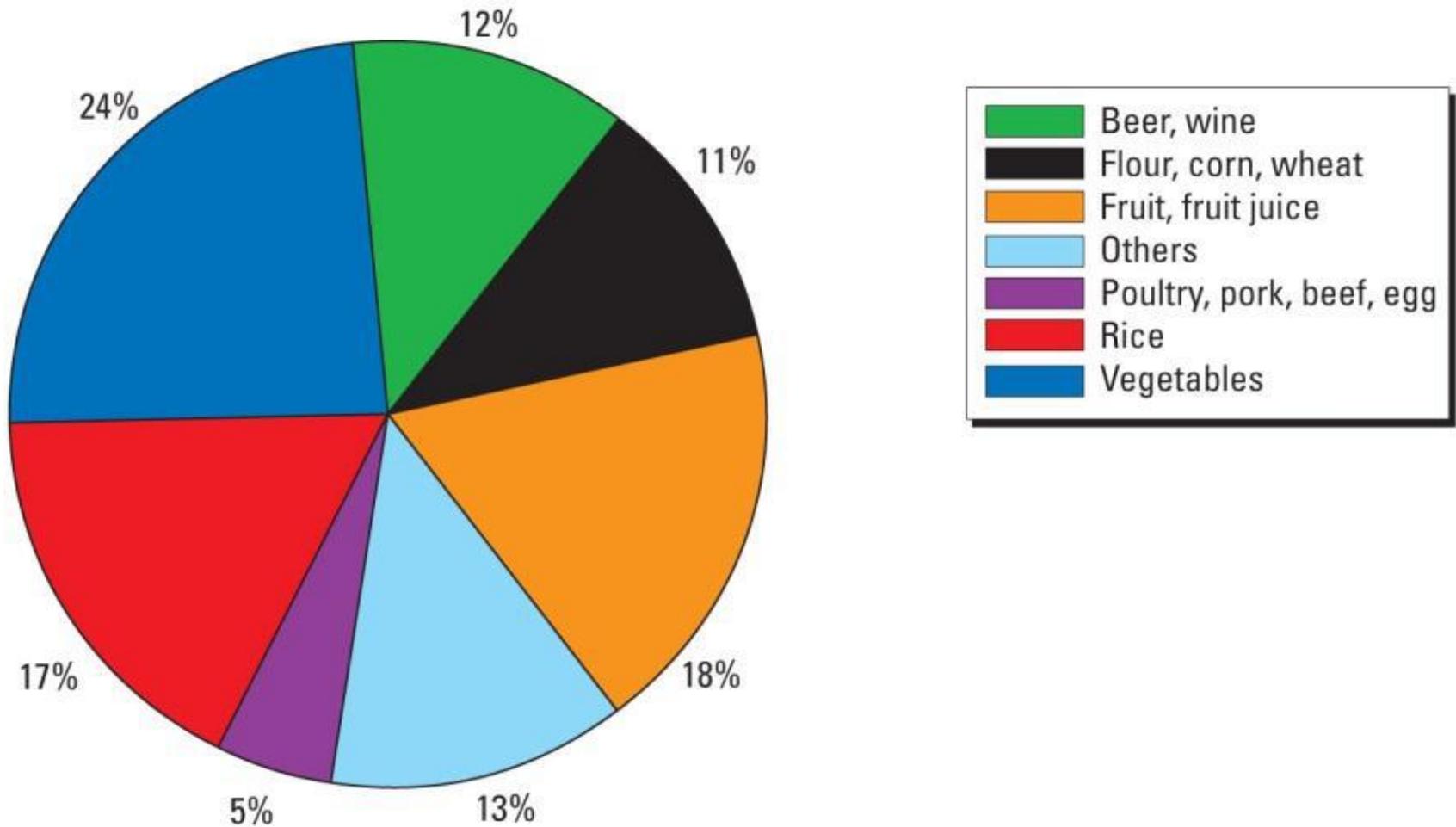


Figure 5. Contributions of iAs intake by foods.

Source: *Probabilistic Modeling of Dietary Arsenic Exposure and Dose and Evaluation with 2003-2004 NHANES Data*, U.S. Environmental Protection Agency (EPA), March 2010, Xue et al.

Engaging Government Agencies – Provide Information and Data



- Tested industry rice samples (provided in 2009)
- Test results shared with FDA



- USA Rice Meetings
- Exponent data sent
- Understand plan for public release of rice data
- Retained samples will be sent



- Discussion on nutritional benefits of rice

Market Issues – Potential Changes

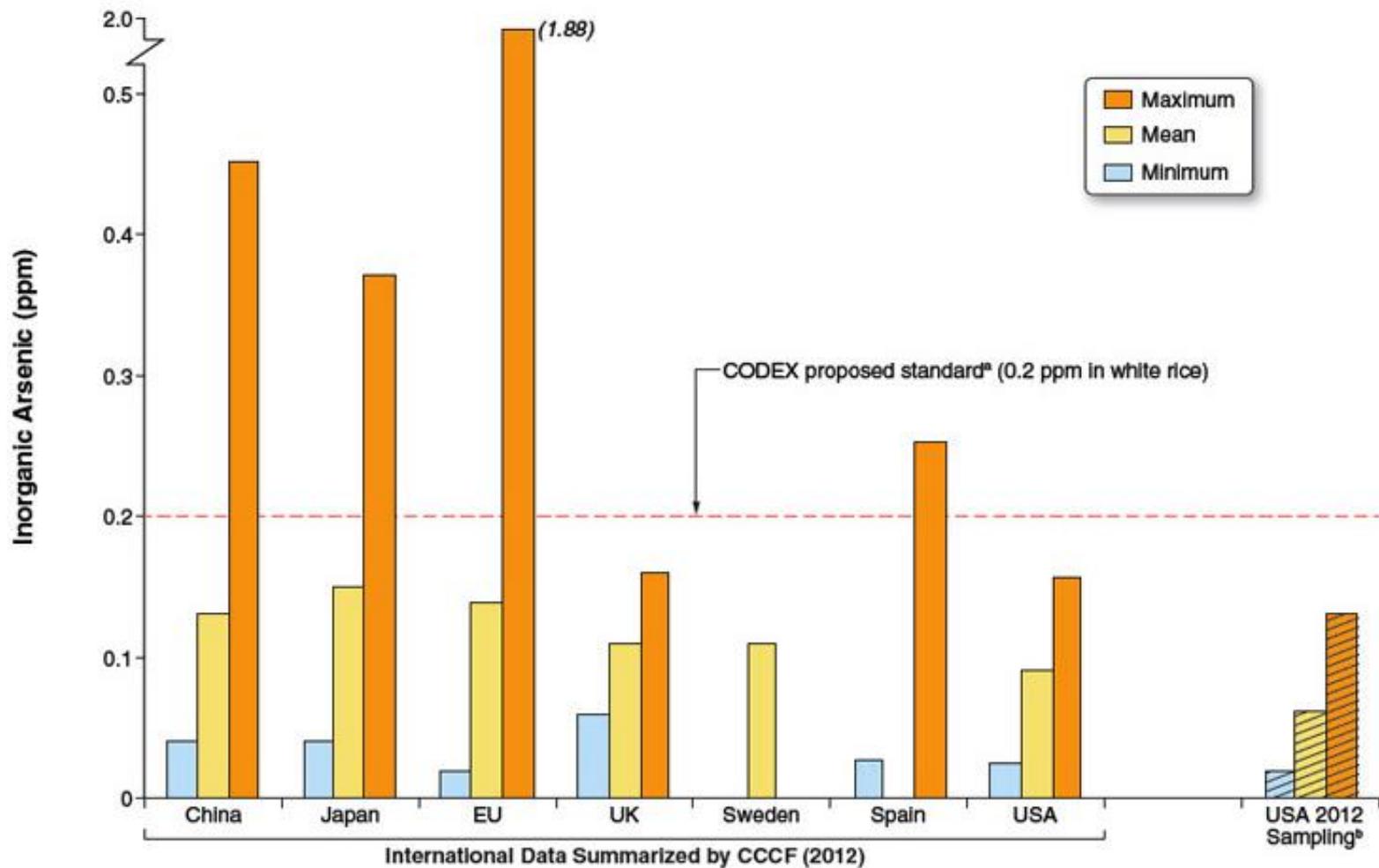


- Rice sourcing changes between regions, states or nations
- Potential government-required mitigation methods at grower, miller or consumer level
- Potential customer-required mitigation methods at grower or miller level
- Potential for differing domestic, foreign national, international and customer driven acceptable levels for total, organic, inorganic, or mix

Market Issues – Potential Results



- Very preliminary discussions have included
 - Changing the way we grow rice
 - Rinsing rice at the mills
 - Precooking rice at the mills
 - Consumer rinsing of rice
 - Removing fields and farms from rice growing
 - Sourcing changes



* CCCF (2012). Proposed draft maximum levels for arsenic in rice. Joint FAO/WHO Food Standards Programme, Codex Committee on Contaminants in Food, Rome, Italy.

^b Rice sampling in 2012 by the USA Rice Federation involving AR, CA, LA, MO, MS, TX.

Figure 1. Inorganic arsenic concentrations in rice

