



Methane emissions from shale gas production sites in Sichuan, China

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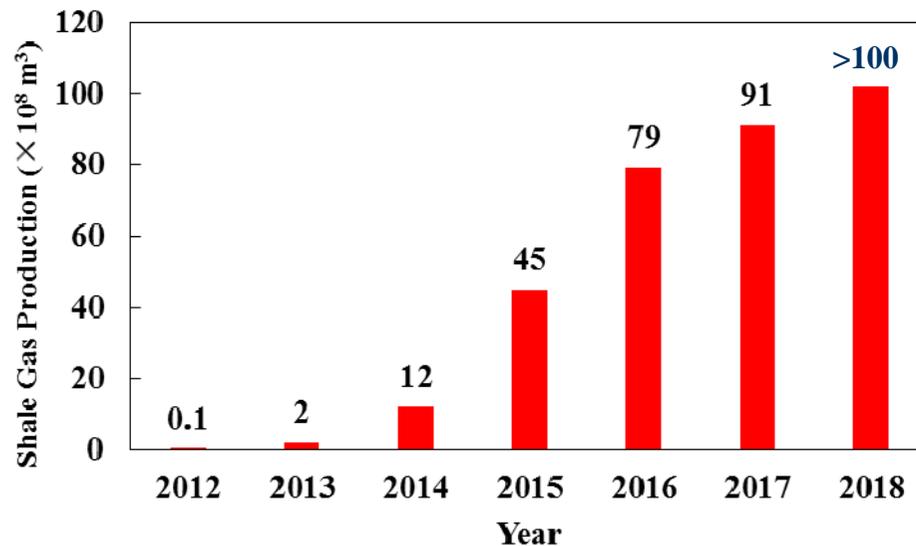
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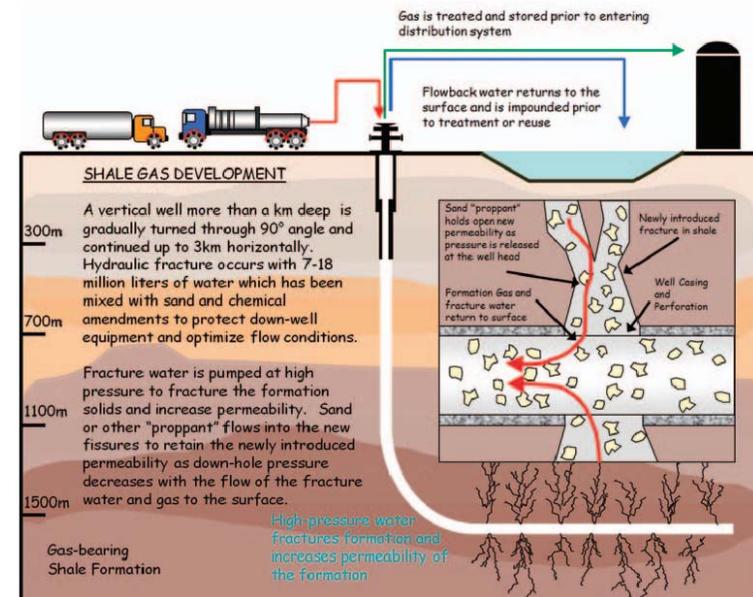


Background

- Shale Gas Production Boosting in China in Recent Years
- Climate Challenge caused by Oil and Gas Production are Raising Attention
- Nine major emission source including Pneumatic Controllers, etc. were identified



Shale Gas Production in China
(Modified from Zheng et al., 2018)



Overview of Shale Gas Production Process
(Dzombak et al., 2011)



Background

GHG Inventory of O&G Industry in China

- Methane emission factors are from the Guidebook of 2005
- Instead of component-level, most emission factors are based on facility-level, especially for natural gas production

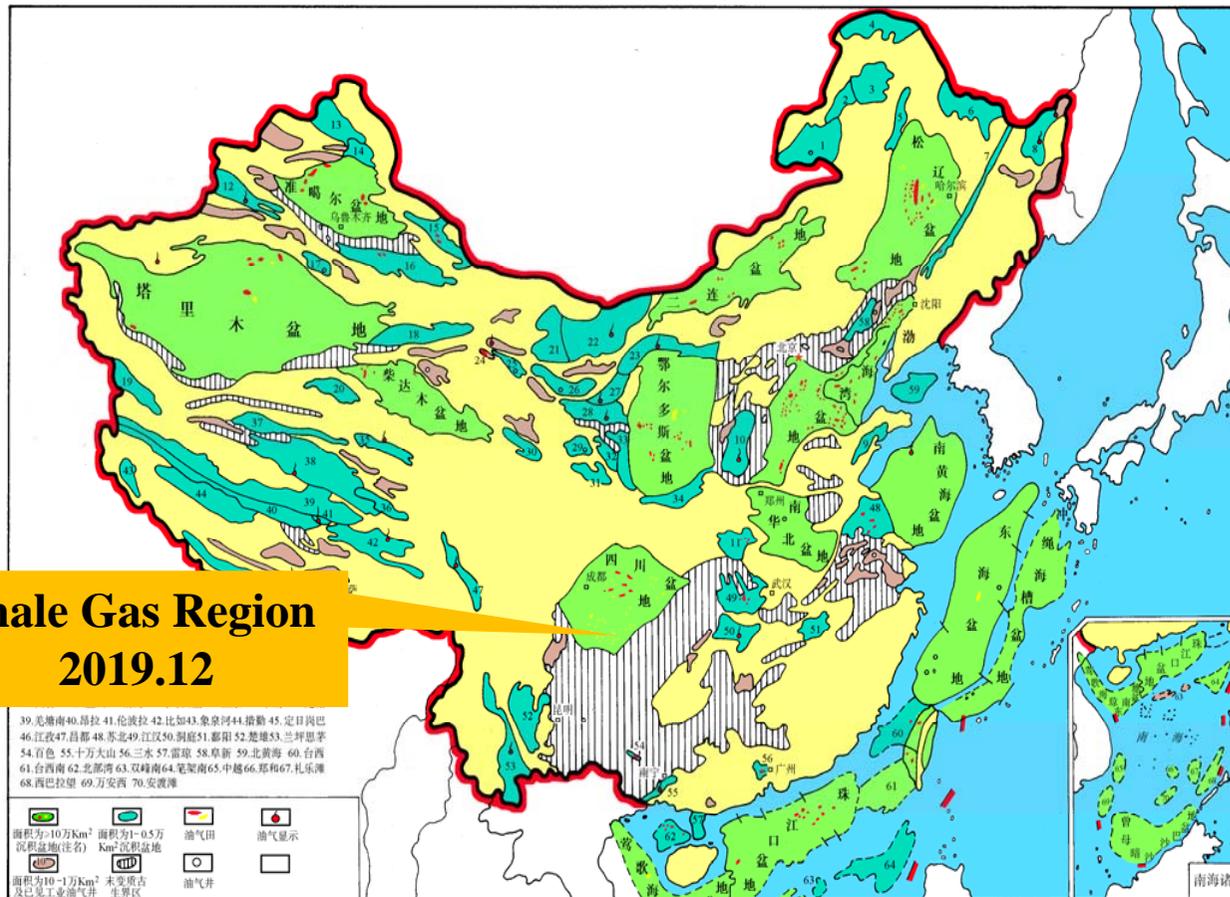
| Natural Gas Exploration | Fugitive | Venting |
|--|---------------------------------|---------------------------------|
| Wellhead | 2.50 ton/(yr • each) | - |
| Gas Gathering Station | 27.9 ton/(yr • each) | 23.6 ton/(yr • each) |
| Metering/Distributing Station | 8.5 ton/(yr • each) | - |
| Gas Storage Station | 58.4 ton/(yr • each) | 10.0 ton/(yr • each) |
| Natural Gas Processing | 403.4 ton/1 bcm | 138.3 ton/1 bcm |
| Natural Gas Transmission | | |
| Compressor Station | 85.05 ton/(yr • each) | 10.05 ton/(yr • each) |
| Metering Station | 31.50 ton/(yr • each) | 13.52 ton/(yr • each) |
| Pipelines | 0.85 ton/(yr • each) | 5.49 ton/(yr • each) |
| Pigging Station | - | 0.001 ton/(yr • each) |

(NDRC, 2014)



Background

Study Area



(Modified from Zou et al., 2018)

Annual Production of the sub-basin: 0.5 billion m³ dry gas
Investigation Period: Dec. 25, 2019 to Jan. 5, 2020
Type: Well sites (18 sites with 79 wells)



Background

□ Basic Setting for Downwind Measurements and Methane Mapping

➤ Downwind Measurements (OTM33A):

Picarro® G2301, McGill® 3D wind anemometer

➤ Site Patrolling:

Picarro® G4302, GPS



Picarro G2301 CO₂ /CH₄ /H₂O





□ Our Investigation tried to answer the following questions:

1. What's the major methane emission source for the shale gas sites?

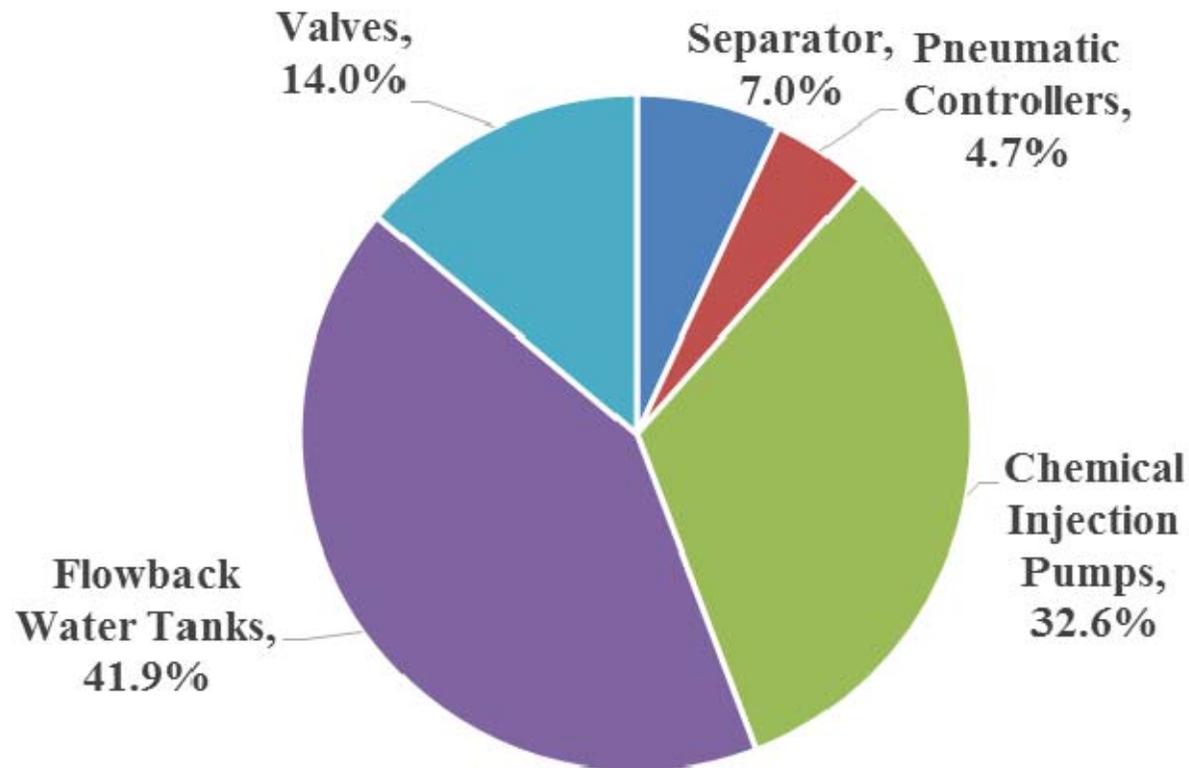
2. What's the methane emission rate for the shale gas well sites?



Methane Emission Source

□ Emission Source

- Flowback water tank was the major source
- Chemical injection pumps were from 2 sites
- Leakage from valves were fixed after inspection

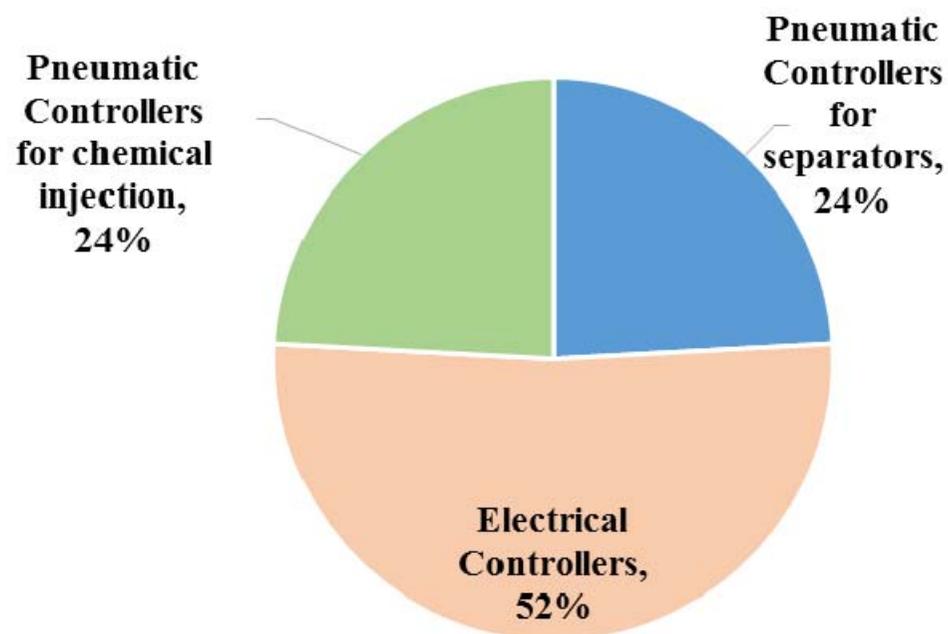




Methane Emission Source

□ Pneumatic Controller

- Pneumatic controllers from separators were mostly no-bleed or low-bleed
- Well sites constructed after 2018 used electric controllers
- All the controllers for chemical injection pumps were natural-gas driven

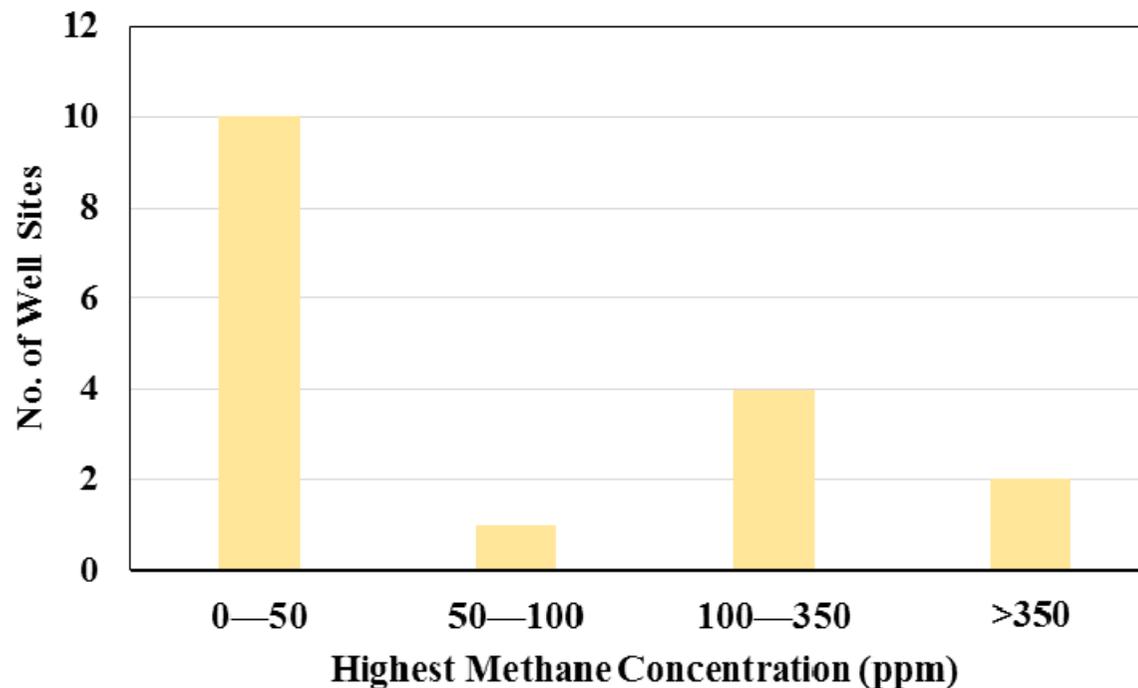




Methane Emission Source

□ Methane Mapping

- Highest methane concentration inside the sites from 2.54 to 459 ppm
- Over 55% of the sites has the highest methane concentration <50 ppm

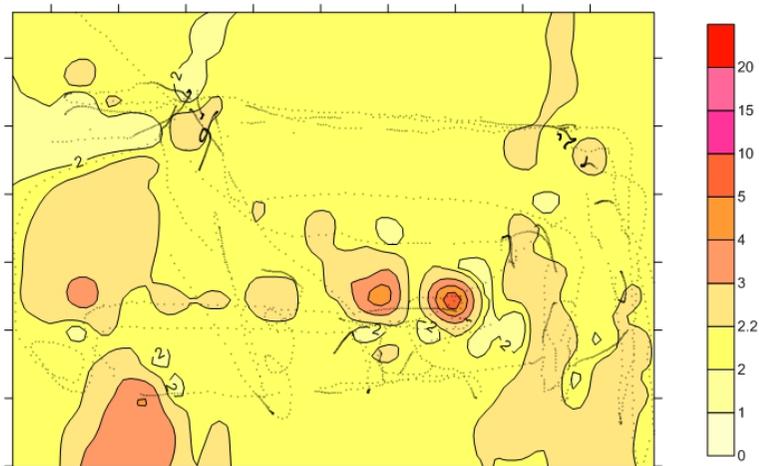




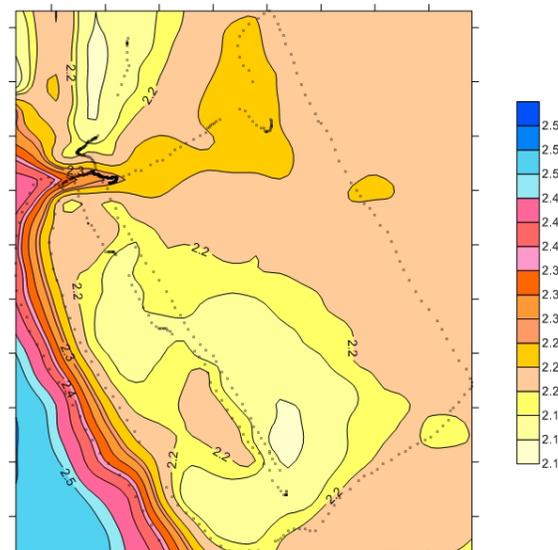
Methane Emission Rate

□ Application of vehicle-based measurements

| Site No. | Average wind speed (m/s) | Methane Release Rate (kg/hr) | Stability Class (PGI) |
|----------|--------------------------|------------------------------|-----------------------|
| 13 | 0.3~0.8 | 0.02~0.2 | 1.5 |
| 11 | | | 3 |
| 3 | | | 3 |



Station 11



Station 3 ¹⁰



□ Take home Message

- **Application of electric controllers could reduce methane emission from shale gas development in China**
- **Flowback water tank is the major source of shale gas production sites, and mitigation options need to be considered.**
- **In mountainous areas such as Sichuan Basin, China, methane quantification methods other than OTM-33A may be applied.**

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➤ **References:**

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Dzombak, D. A., K. B. Gregory, and R. D. Vidic 2011.Elements 7 (3):181-186.

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