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Carlos Lange-Bassani, Ana Cameirão, Rigoberto E. M. Morales, Herri Jean Michel. Modeling Gas Hydrate Growth Kinetics in Water-in-Oil Emulsion for Offshore Petroleum Production Applications. Journée scientifique Codegepra 2017, Nov 2017, Le Bourget du Lac, France. . hal-01646680

**HAL Id: hal-01646680**

**<https://hal.science/hal-01646680v1>**

Submitted on 23 Nov 2017

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# Modeling Gas Hydrate Growth Kinetics in Water-in-Oil Emulsion for Offshore Petroleum Production Applications

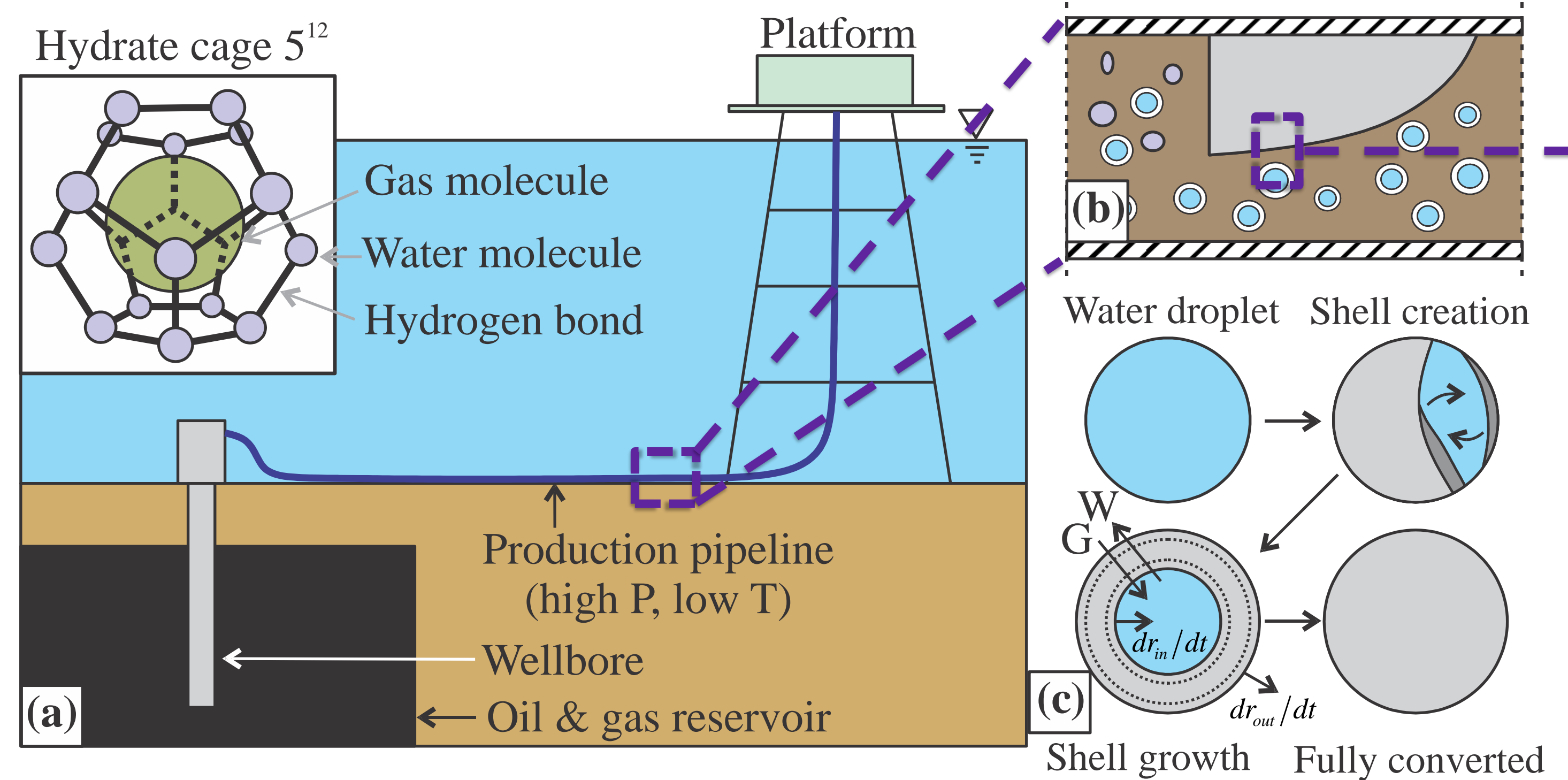
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<sup>a</sup>PEG/SPIN, École de Mines de Saint Etienne, 158 cours Fauriel, CS 62362, F-42023, Saint Etienne, France.

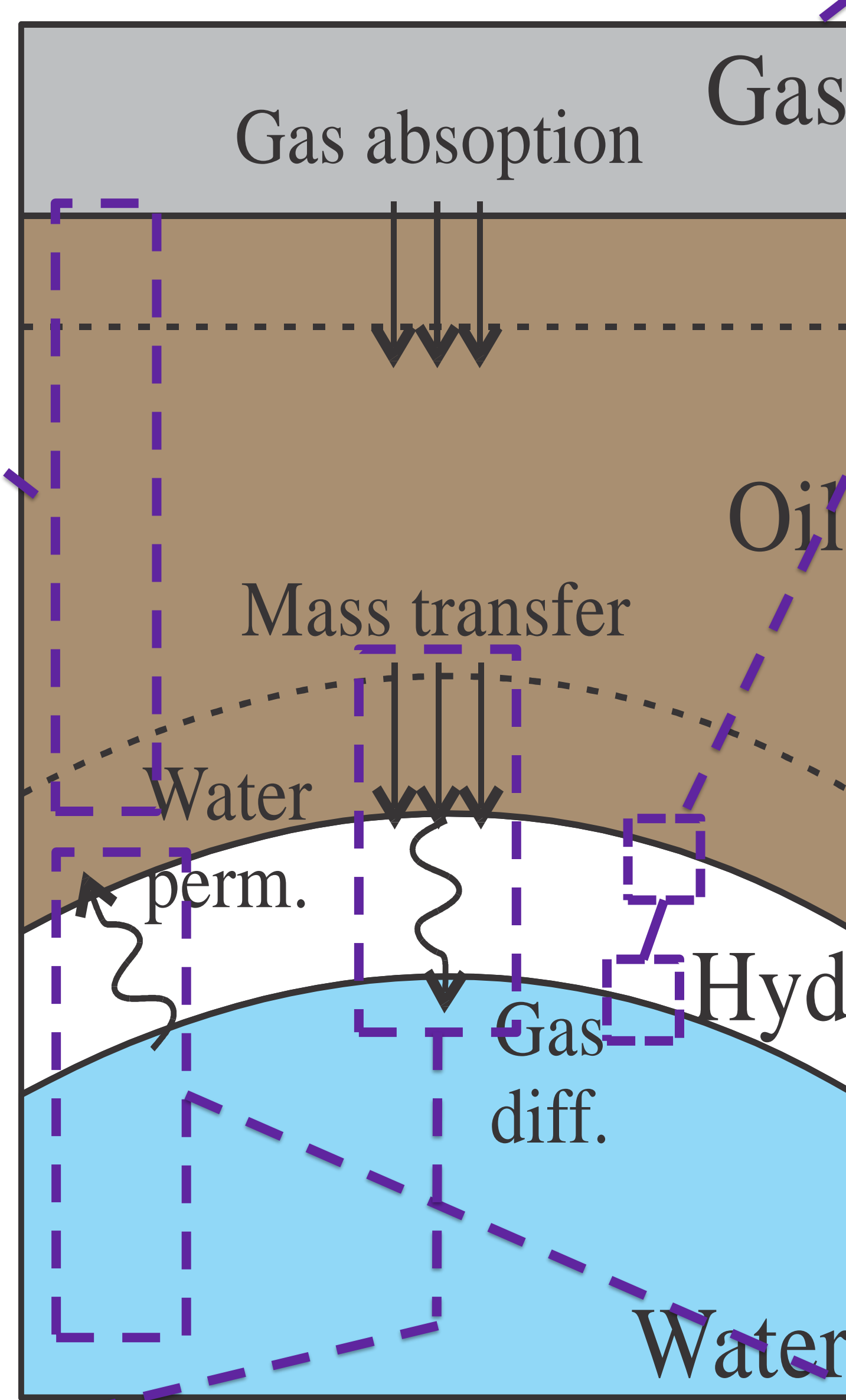
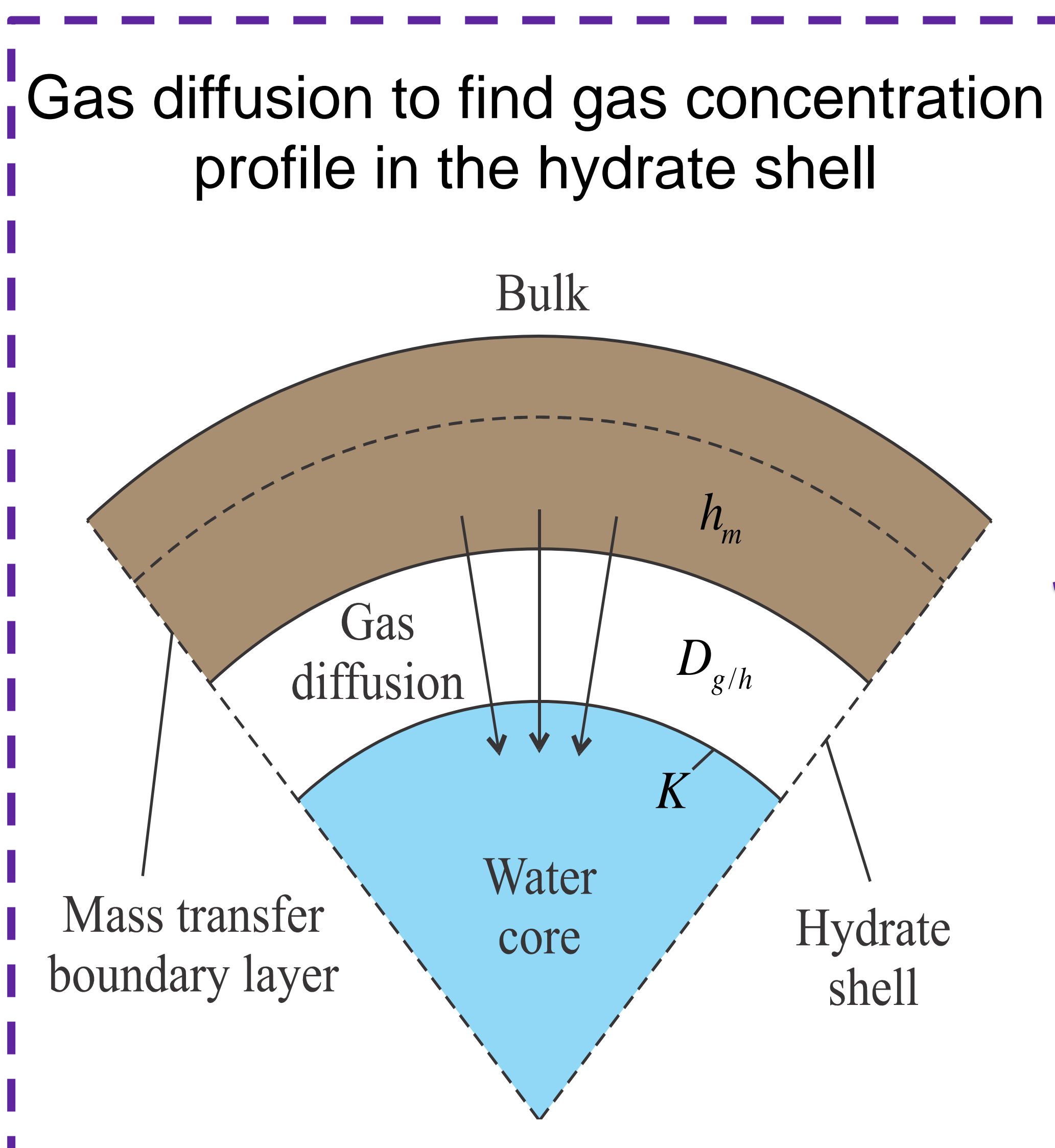
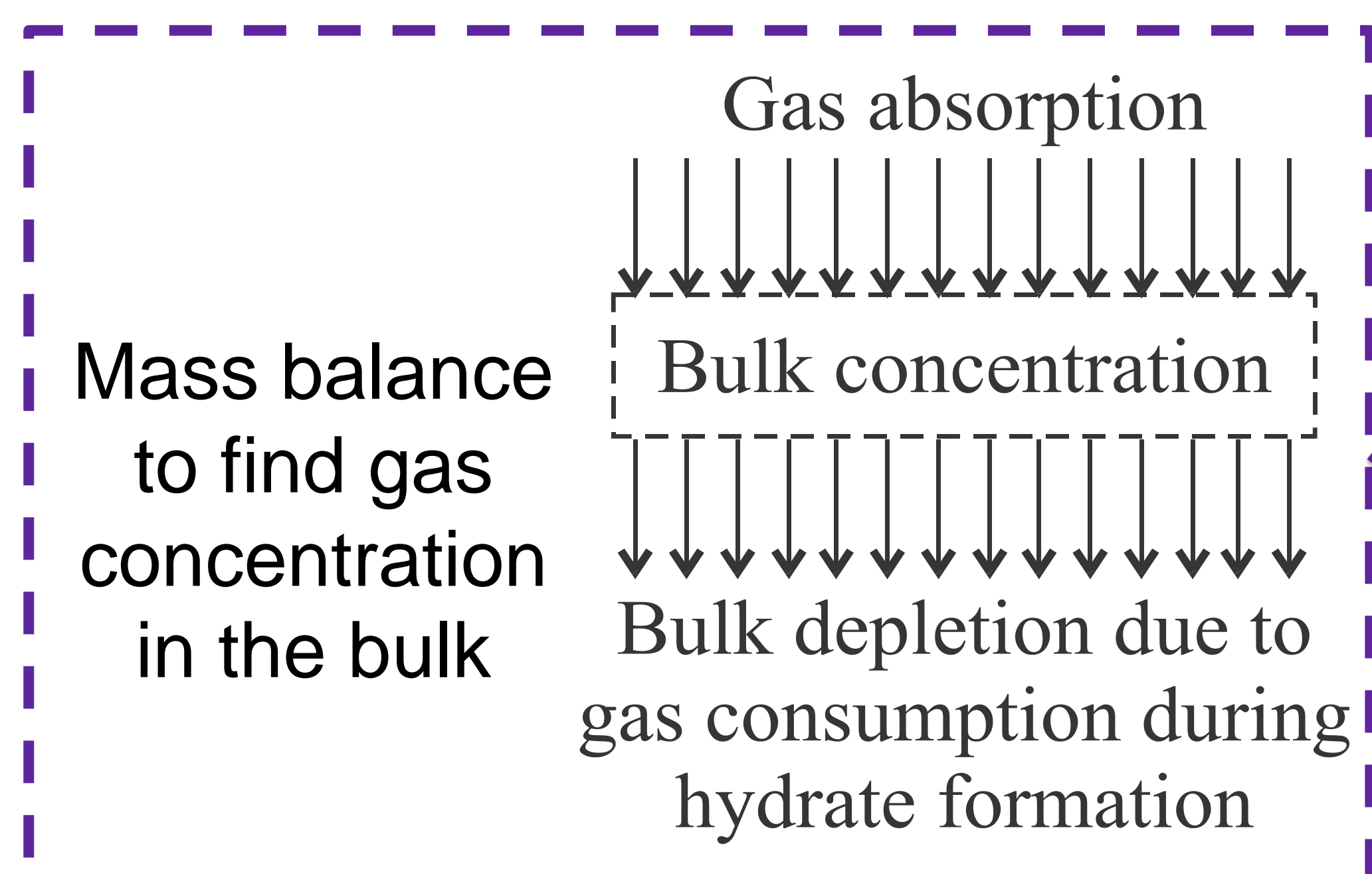
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## Introduction

- ❑ **Objective:** to model gas hydrate growth kinetics based on the multiphase L-L flow pattern
- ❑ **Literature:** still scarce and open models
- ❑ **Main phenomena to be accounted for:**
  - ✓ Gas diffusion and water permeability through hydrate shell
  - ✓ Water core pressurization
  - ✓ Bulk depletion vs gas absorption



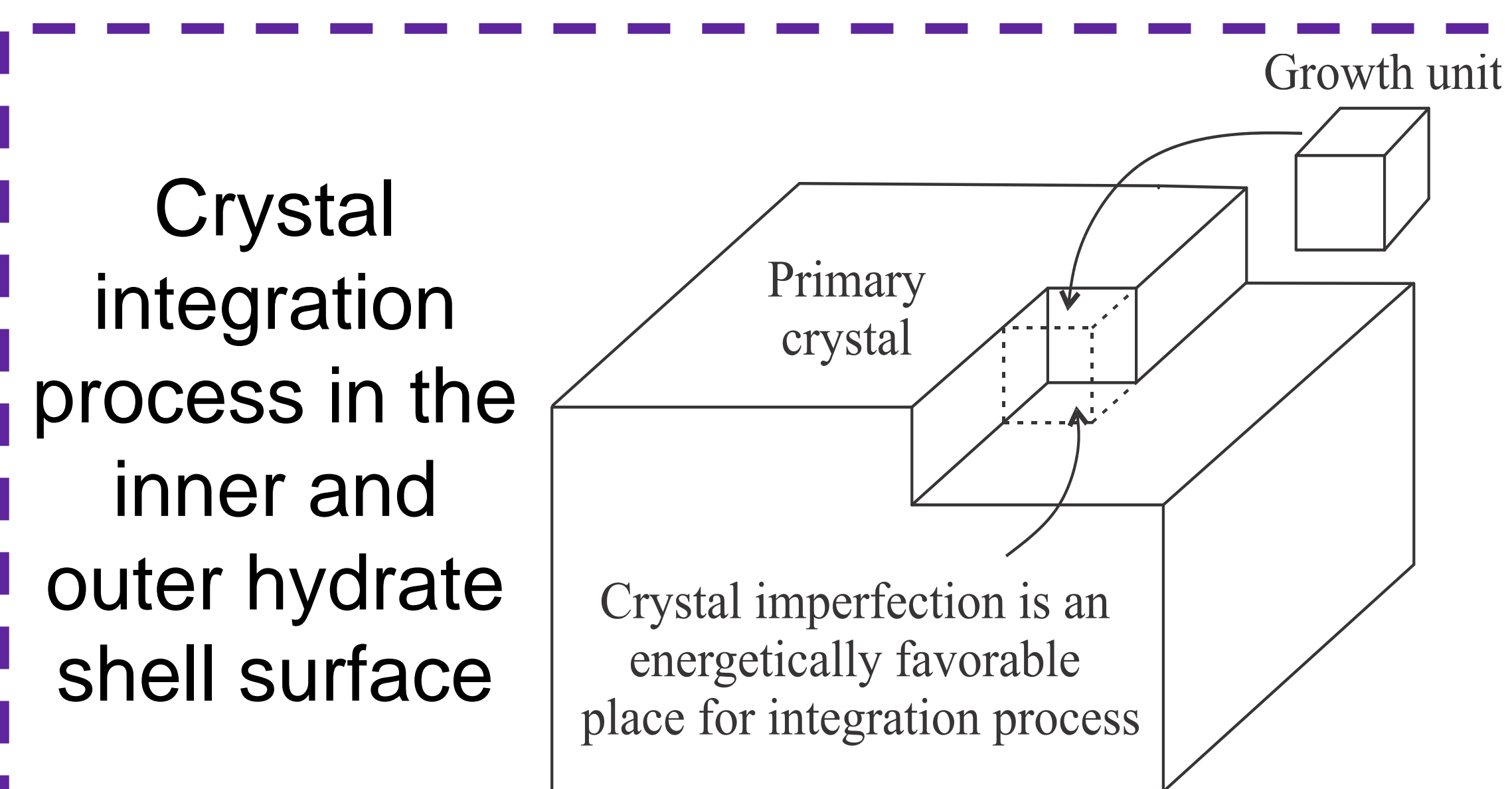
## Mathematical modeling



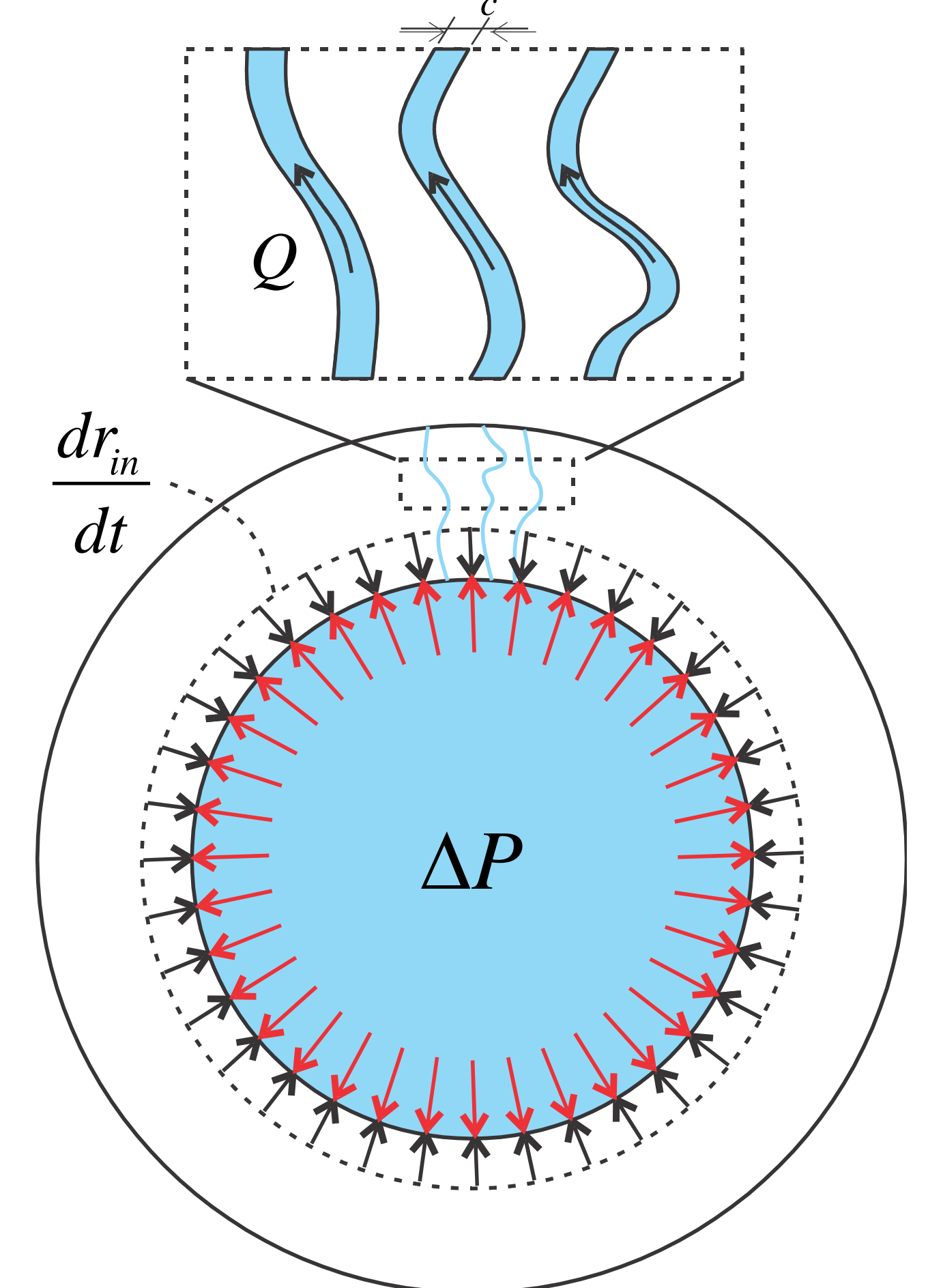
$$\frac{dr_{in}}{dt} = f(r_{in}, r_{out}, C_b, system)$$

$$\frac{dr_{out}}{dt} = f(r_{in}, r_{out}, C_b, system)$$

$$\frac{dC_b}{dt} = f(r_{in}, r_{out}, C_b, system)$$



Inner growth pressurizes water core, which tends to expulse water through hydrate permeability

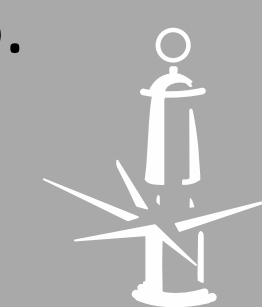


## Conclusions and future perspectives

- ❑ Complete modeling of particle growth based on mass transfer resistances
- ❑ Future coupling with population balance and L-G flow for pressure and temperature prediction along pipeline
- ❑ Future measurement of needed closure parameters → gas solubility in oil, O-W interface tension, crystal integration rate

For more information on the subject:

- ✓ Herri et al., 1999. AIChE Journal, 45(3), 590-602.
- ✓ Shi et al., 2011. Chemical Engineering Journal 171, 1308-1316.



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