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Respiratory hazard identification of combined exposure to gasoline exhaust and respirable volcanic ash in a multicellular human lung model

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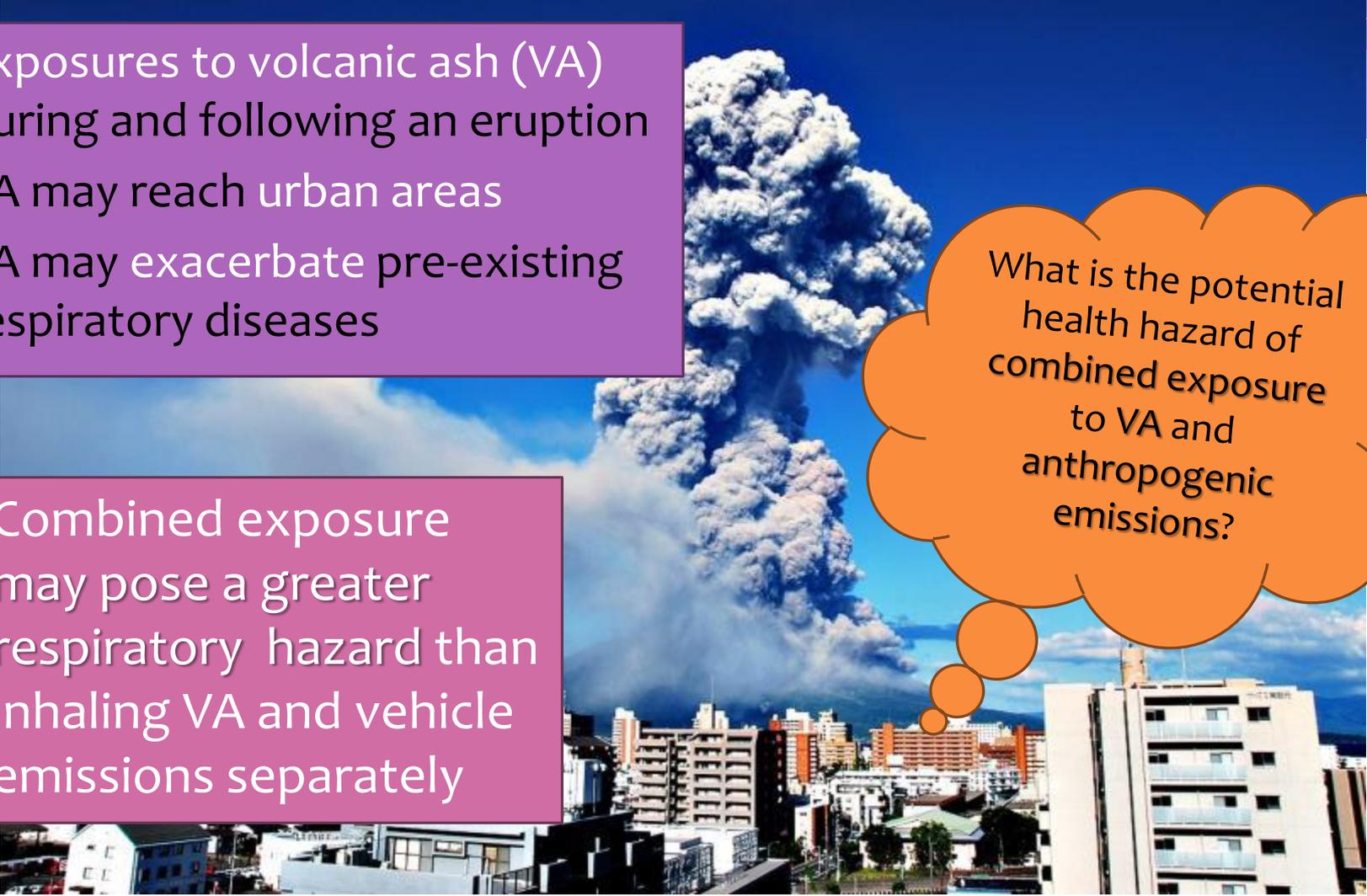
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Introduction: Respiratory health hazard of volcanic ash

- * Exposures to volcanic ash (VA) during and following an eruption
- * VA may reach urban areas
- * VA may exacerbate pre-existing respiratory diseases

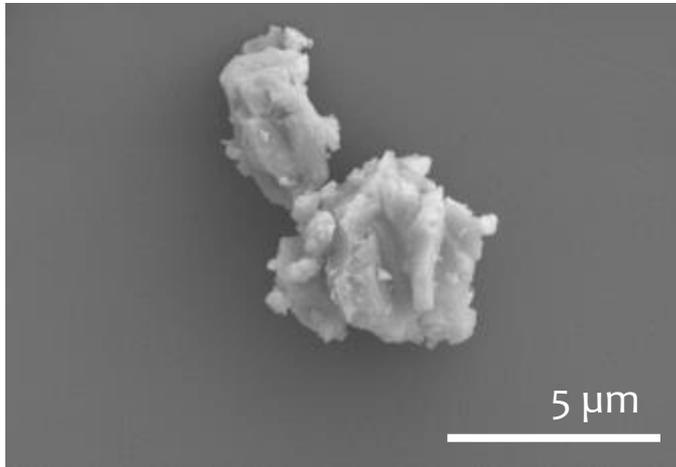
- * Combined exposure may pose a greater respiratory hazard than inhaling VA and vehicle emissions separately

A photograph showing a massive, billowing plume of white volcanic ash and steam rising from a city. The plume is thick and reaches high into a clear blue sky. In the foreground, several multi-story apartment buildings and other urban structures are visible, illustrating the proximity of the eruption to populated areas.

What is the potential health hazard of combined exposure to VA and anthropogenic emissions?

State-of-the-art: Volcanic ash and an urban pollutant

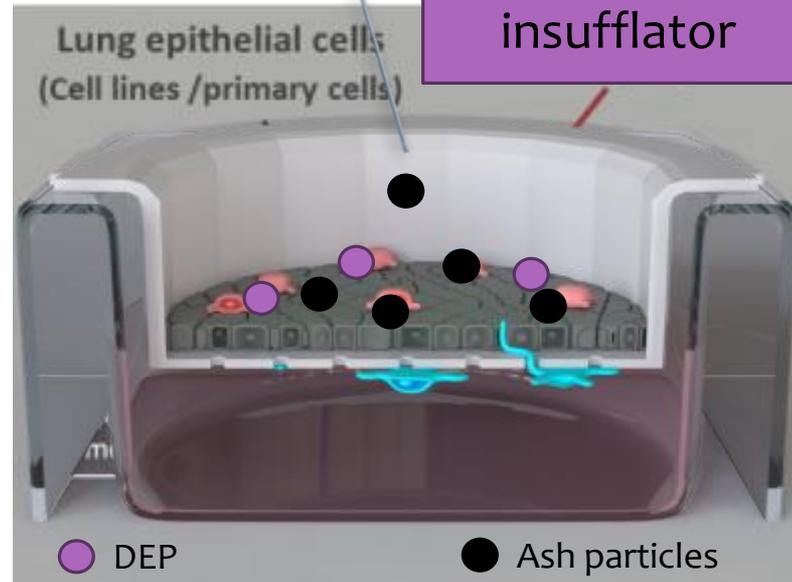
- * < 4 μm material



Tomašek et al. (in prep)



* Dry nebulisation of VA onto the triple cell co-culture at the air-liquid interface using a dry powder insufflator

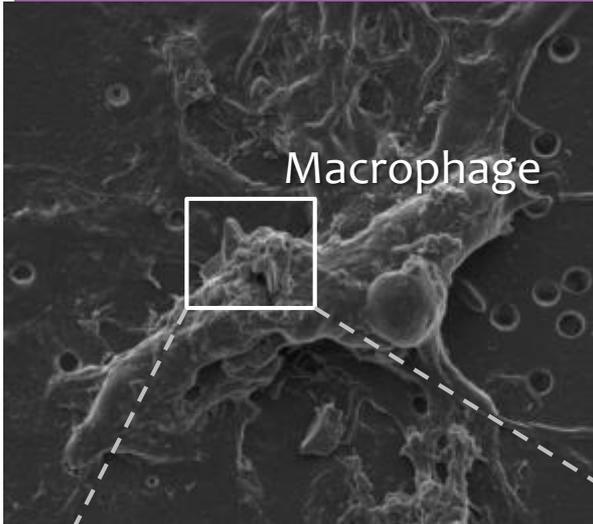
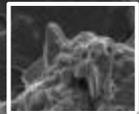


- * Soufrière Hills volcanic ash
- * Diesel exhaust particles (DEP)
 - * NIST 2975
- * First study of combined exposure to VA and DEP

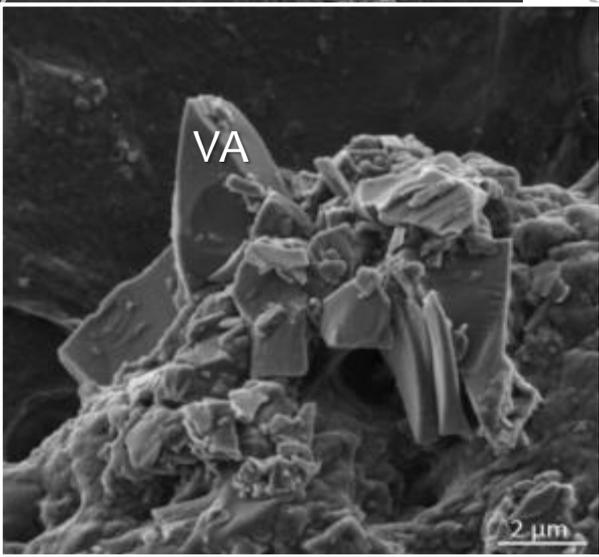
Tomašek et al. 2016, *Particle and Fibre Toxicology*, 13:67

Co-exposure to volcanic ash and diesel exhaust particles

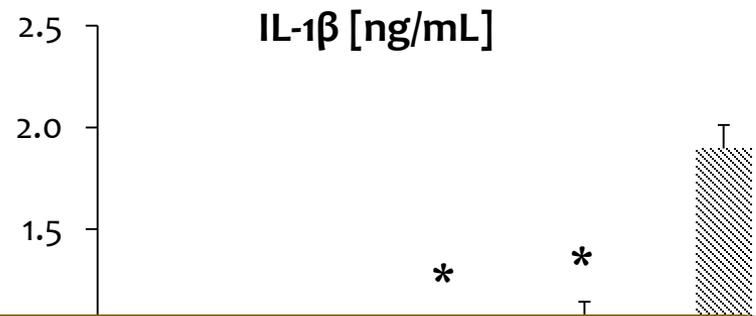
Macrophage



VA



(pro-)inflammatory response



Combined exposure to VA and DEP can promote a heightened and significantly increased (pro-)inflammatory response *in vitro*.

Co-exposure to volcanic ash and complete vehicle exhaust

Combined exposure may cause an increased (pro-)inflammatory response *in vitro*.

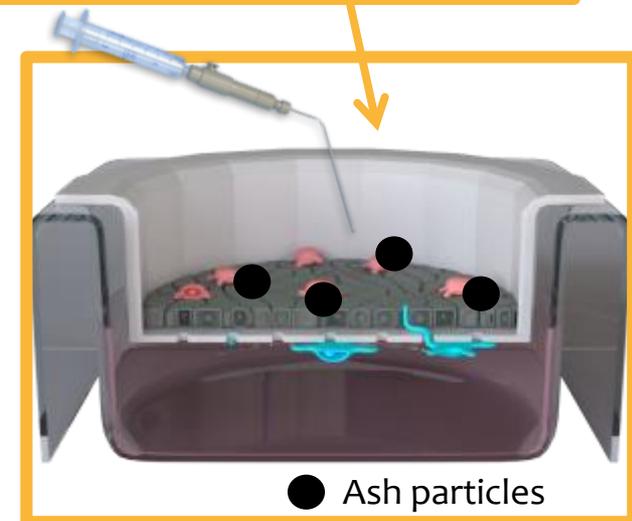
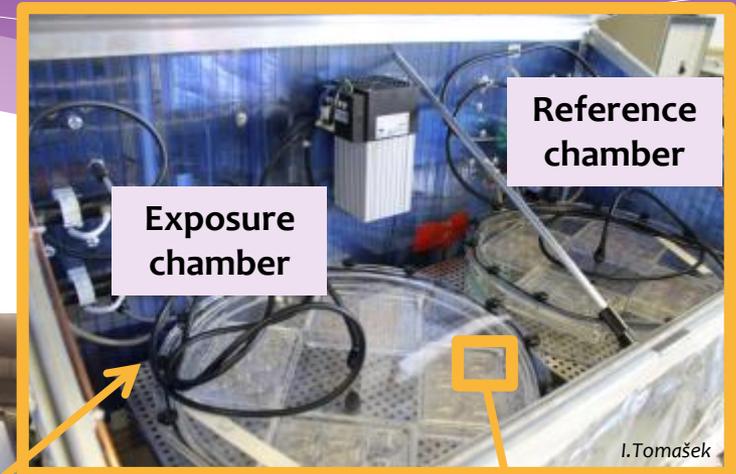
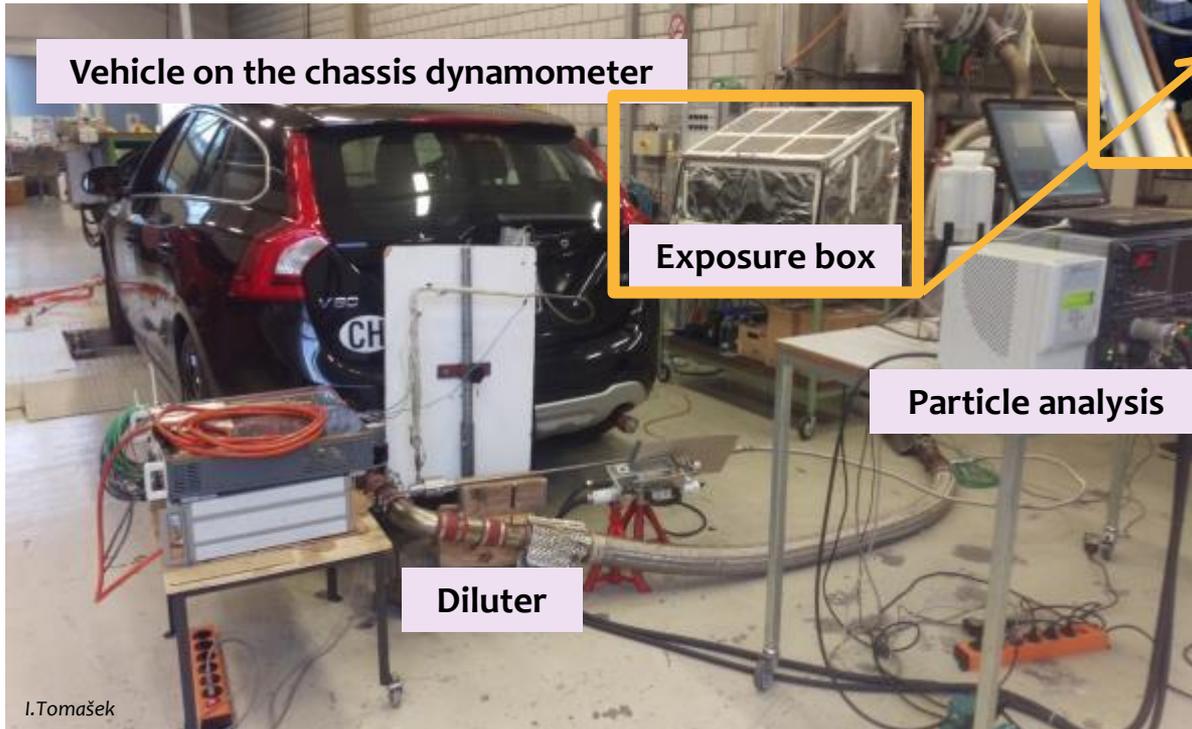
* First study to evaluate the biological impact of combined exposure to respirable VA and freshly-generated complete gasoline exhaust.

n-volcano-erupting-periodically-22-years-
ort-close.html

Methods: Vehicle exhaust exposure system

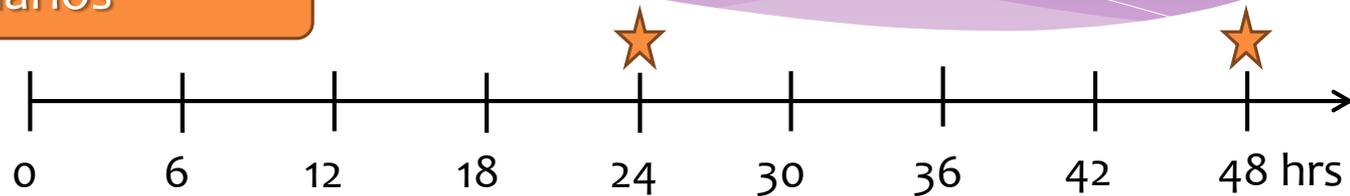
Müller et al. 2010, Environ. Sci. Technol., 44(7), 2632-2638.

- * Gasoline direct injection (GDI) vehicle
- * Triple cell co-culture at the air-liquid interface

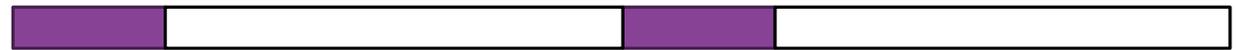


Methods: Cell exposures

Exposure scenarios



Gasoline exhaust (GE)



✘ Soufrière Hills volcano, Monserrat (SHV) OR Chaitén volcano, Chile (ChV)

Gasoline exhaust+volcanic ash

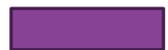


Filtered air (reference)



✘ Soufrière Hills volcano, Monserrat (SHV) OR Chaitén volcano, Chile (ChV)

Filtered air+volcanic ash



Gasoline exhaust exposure



Filtered air exposure



Post-incubation



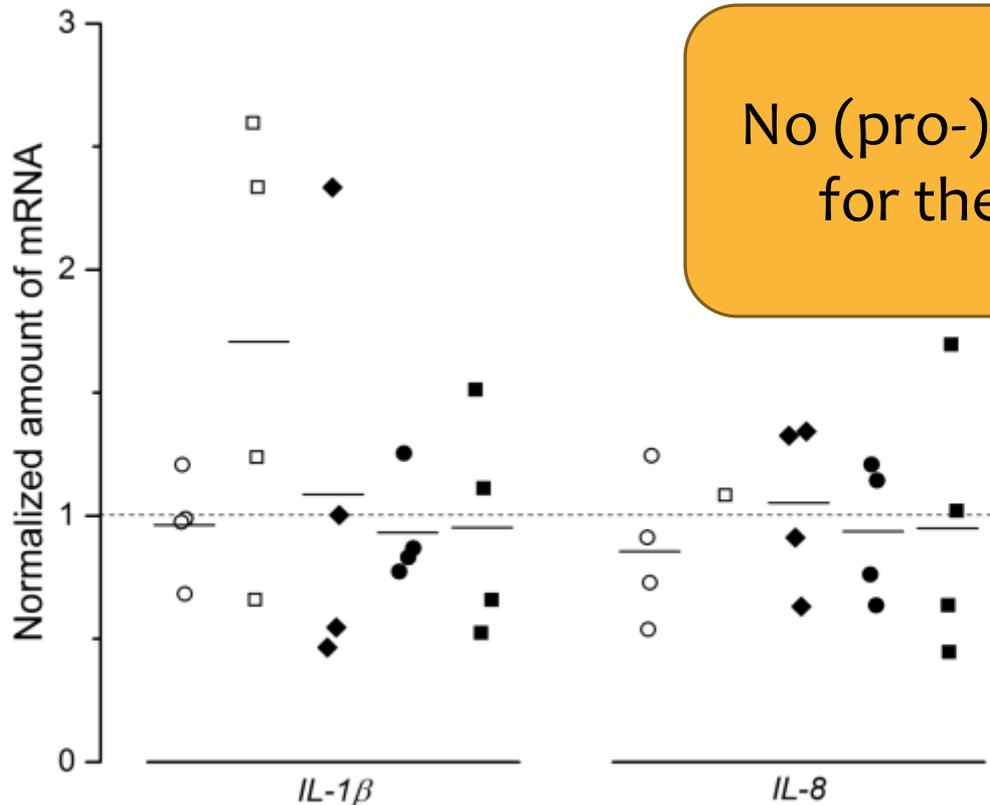
Volcanic ash nebulization



Sampling

Results: (pro-)inflammatory response

(pro-)inflammatory gene expression



No (pro-)inflammatory response for the markers measured.

* Different interactions of the multicellular model with a complete vehicle exhaust as opposed to response to individual particles

Conclusions and implications

- * Considering the present setup and multicellular *in vitro* model used:
 - * The **biological impact** of co-exposures to gasoline exhaust and volcanic ash **is limited**
 - * **Differences in magmatic composition** e.g., silicon dioxide content and also crystalline silica content, **did not affect** the biological response to co-exposures
- * Potential **chronic effects** have not been accounted for and need to be investigated as well as the exposures of individuals with **pre-existing respiratory diseases**

Further studies necessary to clarify the hazard of combined exposures to volcanic ash and urban pollution.

Ongoing work

- * Chemical interaction of vehicle exhaust gases with the surface of volcanic ash

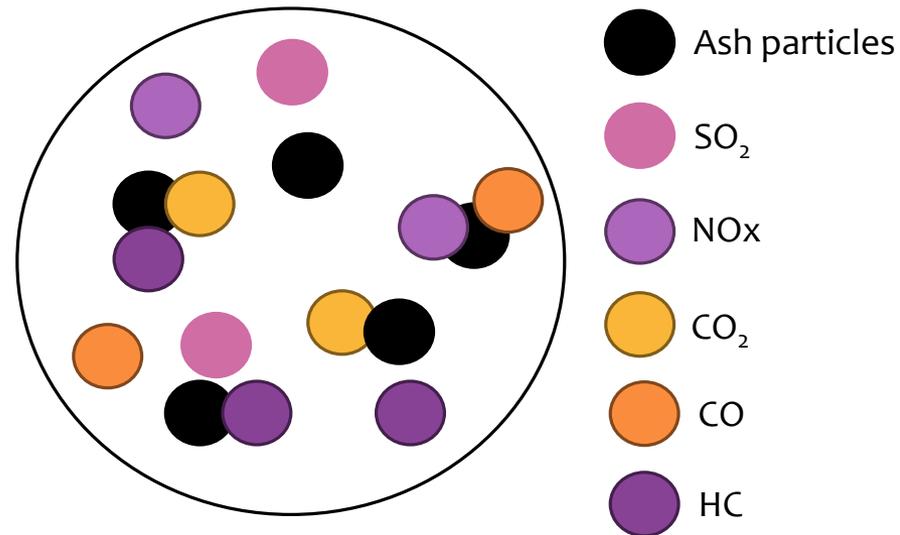
- * gas uptake by particle surfaces



- * potential alterations of the surface reactivity of the ash



- * a different toxic response?



Thank you!



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